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DEPARTMENT OF DEFENSE

JOINT ORDNANCE TEST PROCEDURE (JOTP)-010B

SAFETY AND SUITABILITY FOR SERVICE ASSESSMENT TESTING FOR SHOULDER LAUNCHED MUNITIONS

Joint Services Munition Safety Test Working Group

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Joint Ordnance Test Procedure (JOTP)-010B
Safety and Suitability for Service Assessment Testing for Shoulder Launched Munitions

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ABSTRACT:

Joint Ordnance Test Procedure (JOTP)-010 is intended to act as a munition type specific document dealing specifically with the necessary safety testing and assessments for shoulder launched munitions to enter service within the North Atlantic Treaty Organization (NATO) community. Two Safety and Suitability for Service (S3) test approaches, analytical and empirical, are presented in this JOTP with the intent that the manager of the test program shall select the more appropriate approach for the munition under test. The munitions covered by the JOTP include reloadable and non-reloadable shoulder launched missiles, rockets, and projectiles.

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This Joint Ordnance Test Procedure (JOTP) shall serve as the US Joint Services Safety and Suitability for Service Test Procedures with regards to shoulder launched munitions until which time the Allied Ammunition Safety And Suitability for Service Assessment Test Procedure (AAS3P-10 (B)) is approved by NATO Allied Committee 326 (AC326). Upon approval of the AAS3P, thorough review of this document shall be conducted with the intent to supersede.

APPROVING AUTHORITY:

J. T. McGough   17 Nov 16
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Deputy Director (Acting), Land Warfare & Munitions
Office of the Under Secretary of Defense for
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DEPARTMENT OF DEFENSE
JOINT ORDNANCE TEST PROCEDURE

*Joint Ordnance Test Procedure (JOTP)-010B 09 May 2016
DTIC AD No.

SAFETY AND SUITABILITY FOR SERVICE ASSESSMENT TESTING FOR SHOULDER LAUNCHED MUNITIONS

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1. INTRODUCTION.

This Joint Ordnance Test Procedure (JOTP) is aimed at the Safety and Suitability for Service (S3) Assessment Testing for Shoulder Launched Munitions. JOTP-1 provides general discussion of Safety and Suitability for Service Assessment Testing. JOTP-10 is intended to act as a munition type specific document dealing with the necessary safety testing and assessments for shoulder launched munitions to enter service within the NATO community. Two S3 test approaches, analytical and empirical, are presented in this JOTP with the intent that the manager of the test program shall select the more appropriate approach for the munition under test.

In assessing S3 it is necessary to assign some form of service life to the item. This is a prediction of the amount of environmental stress the item should be able to withstand without degrading to an unsafe condition based on a risk assessment. These predictions are less likely to be valid the longer an item stays outside of a controlled storage environment as the environment becomes more variable. In-Service Surveillance (ISS) provides the means by which initial service life estimations can be validated or revised to ensure safe and reliable use throughout the required service life. The use of a robust ISS program in conjunction with initial S3 testing of a munition provides a means to assess an item throughout its life. The through life implementation of S3 and ISS techniques is often referred to as Whole Life Assessment (WLA).

This document was developed within the international community and is written with references to both US and NATO test procedures to provide a framework for international procurement and test programs. Table I2-1 (Appendix I, Annex 2) provides cross reference of similar national and international test standards. Whilst each test standard often has unique requirements, the table does not imply the standards are the same or interchangeable. Tailoring of the test procedures and severities in this document is not encouraged. If tailoring is determined to be necessary, the tailoring may be carried out in accordance with the following general principles:

a. The tailored environment shall be at least as severe as the expected life cycle environment;

b. Any alternative test standards / methods that are utilized shall be technically equivalent or superior to the referenced standards / methods;

c. The tailored test procedures and severities, along with full justification / rationale shall be documented as part of the S3 assessment report;

d. Tailoring shall be approved by the relevant National Authority prior to test.

2. <u>SCOPE</u>.

This document was developed within the international community and is written with references to both US and NATO test procedures to provide a framework for national and international procurement and test programs. Table I2-1 (Appendix I, Annex 2) provides cross reference of similar national and international test standards. While each test standard often has unique requirements, the table does not imply the standards are the same or interchangeable. However, international test standards, or test methods, may be substituted for the national test standards

referenced in the JOTP following the general tailoring principles discussed in Paragraph 1 of this document.

2.1. Purpose.

The purpose of this JOTP is to guide personnel involved in the planning and implementation of S3 assessment testing of munitions to enable appropriate evidence to be collected covering the entire life cycle. The objective of the safety test program defined by this JOTP is to provide data to demonstrate that the munition will be “safe for use”, as defined in JOTP-1, throughout the potential deployment possibilities in NATO service.

2.2. Application.

The guidance provided in this JOTP is applicable to NATO, multi-National collaborative and National acquisition of reloadable and non-reloadable shoulder launched munitions. The munitions covered by the JOTP include shoulder launched missiles, rockets and projectiles as defined in Section 3 of this document. This includes munitions intended for use in reloadable, recoilless launchers, although this document does not specifically address S3 testing of the reloadable launcher. This document excludes launchers for gun ammunition and grenades of 40 mm and below.

2.3. Limitations.

This JOTP is not intended to be used in the assessment of effectiveness, reliability or performance of a munition unless failure to be reliable or to perform effectively is deemed to represent a direct and immediate safety hazard to the user or other personnel. However, the data may be used in the support of effectiveness, reliability, or performance assessment. This document does not define the In-Service Surveillance or Stockpile Reliability test requirements; however, the data may be used in the support of planning for these requirements. Refer to STANAG 4675 and AOP-62, 63, and 64 for further guidance.

3. TERMINOLOGY.

Terminology in this JOTP are taken from the NATO Terminology Management System (NTMS) where possible. Terminology specific to this document and additional notes are added for clarity. Refer to JOTP-1 for terminology related to Safety and Suitability for Service test procedures.

3.1 Temperature Conditioning.

Exposure of a munition to a thermal environment in preparation for a test event at a specified test temperature.

3.2 Solar Radiation Equivalent (SRE) Temperature.

In environmental testing, the maximum temperature achieved by energetic material when exposed to cycles of high temperatures in combination with solar radiation during a laboratory test.

Note: The SRE is defined as the maximum temperature value experienced by the energetic material (e.g., motor propellant, warhead, fuze) during the solar test. Determination of this value will require exposure of an inert, internally instrumented munition, with similar thermal characteristics to the complete round, to the full solar test requirement defined in Allied Environmental Conditions and Test Publication (AECTP) 200, Category A1. The SRE temperature should be determined for the packaged and unpackaged state. In the absence of this data, a value of +71 °Celsius (C) should be used for the SRE temperature.

3.3 Temperature Stabilization.

Temperature stabilization is achieved when the part of the item considered to have the longest thermal lag is changing no more than 2 °C per hour.

Note: Since it may not be practical to monitor the part of a live munition with the longest thermal lag during test without damaging seals, the stabilization time may be determined prior to live munition testing using an inert, internally instrumented munition, with similar thermal characteristics to the complete round. The stabilization time will typically be required for the munition in both the unpackaged and the transport configurations and at the hot and cold temperature extremes. For packaged configurations, stabilization times are dependent upon the dimensions of the container, container dunnage, and the air gap between the munition and container.

3.4 Ready-To-Fire Configuration.

The configuration of a munition or weapon system immediately prior to firing when all preparatory cautionary measures are completed.

Note: For a shoulder launched munition, this may include removal of an end cap, extension of the launch tube, or installation of an ancillary piece of hardware.

3.5 Non-Reloadable Shoulder Launched Munition.

Rocket, missile, or projectile including all propulsive, explosive, safe and arm, and initiation devices in one single-use, disposable launcher.

Note: External sights, command launch units, and triggering devices may be attached to facilitate operation.

3.6 Reloadable Launcher.

Reusable device used to aim and launch rockets, missiles, or projectiles.

Note: For the purpose of this document, this device would typically include a barrel, sighting mechanism, and trigger mechanism.

3.7 Reloadable Munitions.

Rocket, missile, or projectile including all propulsive, explosive, safe and arm, and initiation devices capable of being loaded and fired from a reloadable launcher.

4. FACILITIES AND INSTRUMENTATION.

4.1 Facilities.

All test facilities utilized must suit specific test requirements and provide adequate protection for personnel and equipment in accordance with local and national regulations for testing of hazardous material. Note that although it is not necessary for all the facilities to be co-located, consideration should be given to the safe transport of potentially degraded test articles between test facilities. In addition to the requirements provided in Appendix F, Table F-1, test facilities shall be prepared for the handling and possible disposal of explosive items.

4.2 Instrumentation Accuracy And Calibration.

The accuracy and calibration requirements for instrumentation and test equipment used for control or monitoring are typically specified in the referenced test methods / procedures. Where such requirements are not specified in the referenced test methods / procedures, the accuracy shall be equal to at least 1/3 of the tolerance of the variable being measured. Recommended default tolerances for common test parameters are provided in Appendix F, Table F-2. Where there is conflict between these recommended values and any requirements stated in the referenced test methods / procedures, the requirements of the referenced methods / procedures take precedence. All instrumentation and test equipment shall be calibrated periodically to laboratory standards whose calibration is traceable to national laboratory standards. The test facility shall maintain the calibration records.

5. LIFE CYCLE ENVIRONMENTAL PROFILE (LCEP).

5.1 LCEP.

Shoulder launched munitions are likely to encounter the life cycle environments shown in Figure 1. Figures 3 and 4 illustrate general test flows associated with these environments. Detailed tests flows are provided in Appendix B of this document as sequential test flowcharts and munition allocation tables. Test guidelines are presented in Appendix C and rationale are provided in Appendix A. An attempt has been made to define test flows such that environmental tests are conducted at representative points in the life cycle. These test flows are based upon the applicable environmental factors for storage, transportation, and deployment selected from AECTP 100, Annex A along with the generic usage profiles from AECTP 100, Annex E. Testing in accordance with this life cycle sequence and combining environments (i.e., vibration with temperature) is required to determine if the interaction (synergistic effect) and/or the sequence in which environments are experienced may result in a safety hazard. If the munition specific LCEP identifies environments or usage profiles significantly in excess of those provided in this document, the test specifications should be adjusted accordingly.

5.2 Deviations.

Deviations from these LCEPs contained in this document shall be approved by National S3 Authority(ies) or other appropriate Authorities prior to the start of testing. The rationale used in tailoring shall be documented and retained as part of the Munition Safety Data Package as noted in Annex C of AOP-15.

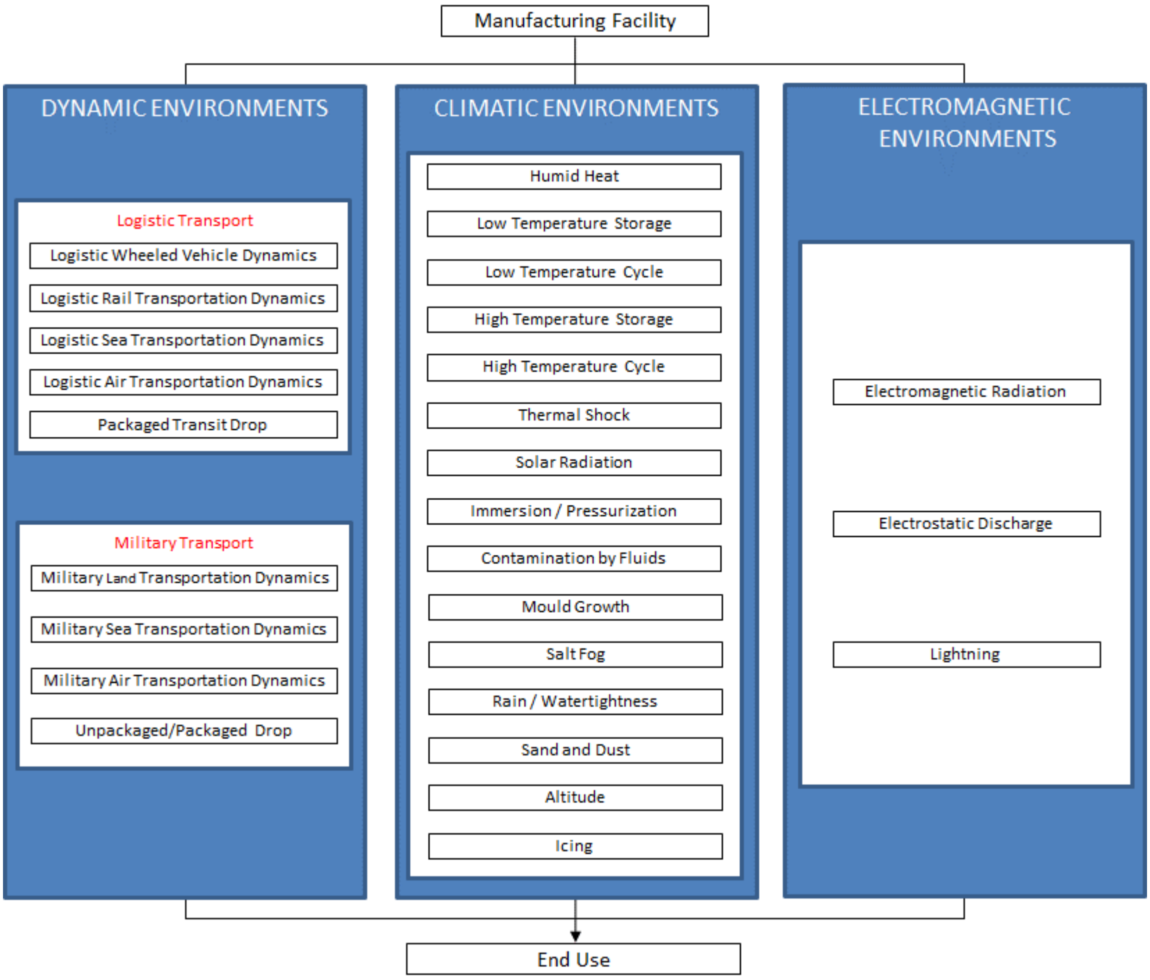


Figure 1. Expected Environments for Shoulder Launched Munitions.

6. SAFETY TEST PLANNING.

6.1 Overall Test Objectives.

The objectives of the safety tests are to provide data to demonstrate that the munition is "safe for use" as defined in JOTP-1. To achieve this, safety tests must provide data to determine the following:

a. Existence and nature of actual and potential munition hazards to personnel and equipment.

b. Safety of the munitions throughout the planned LCEP including storage, transport, maintenance, training, operations, firing, and disposal.

6.2 Data Sources.

Safety assessment of munitions is an evolutionary process, which begins in the early design phase of the munition and continues after deployment of the munition. The data gathered during the S3 tests described in this document should not be considered the exclusive source of data to support the safety assessment. Other sources of safety data such as the ones described below shall be considered.

6.2.1 Design and Test Data Review.

Review of existing safety, design and test data is recommended prior to development of the test plan in order to identify any potential hazards and their causes. Specifically this should include review of documentation relating to munitions requirements, design, safety and any prior testing, including data from component and munition level performance and safety testing (engineering-design or component-development tests). The degree to which this JOTP is followed and the degree to which other data are accepted in place of these JOTP tests depend on the characteristics of the munition and on the credibility and completeness of existing safety data. These reviews and this JOTP must be used to develop the detailed test plan and shall be in accordance with the National health and safety standards and regulations. If the data review indicates a high probability of passing a test, then the test procedures described in this document may be conducted. If the review indicates probable shortcomings in the munition, or if component and munition level performance test data are insufficient, then the procedures of this document should be expanded accordingly to validate the safety of the munition.

6.2.2 Safety Assessment Report (SAR).

The SAR is a formal document that identifies potential hazards and mitigations which, in accordance with standardized procedures, shall be submitted by the munition developer prior to commencement of testing. The SAR shall delineate the safety related characteristics of the munition, identify potential hazards and assess severity and probability of the mishap risk of each identified hazard, and recommend procedures and precautions to mitigate hazards to an acceptable risk.

6.2.3 Weapon Danger Area Analysis.

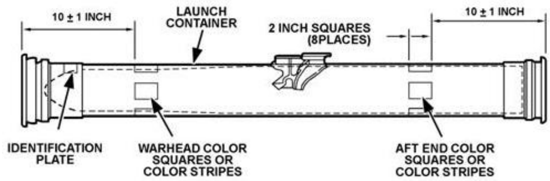
Prior to performing any live firing tests, a weapon danger analysis has to be performed. Further guidance may be found in STANAG 2240, Allied Range Safety Publication 1 (ARSP-1 VOL II) Weapon Danger Areas / Zones For Unguided Weapons For Use by NATO Forces in a Ground Role.

6.3 Test Tailoring.

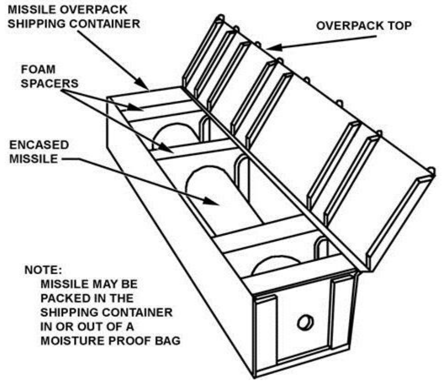
The safety tests recommended in this document are intentionally conservative to account for a wide range of deployment possibilities in NATO service. Test tailoring may be necessary for a variety of reasons including test conduct safety considerations, variation of deployment

requirements and/or life cycle environmental profile, the need to address nation specific requirements and/or factors that affect test sample sizes. When nation specific requirements conflict with requirements in this document, the reference tables in Appendix I may be used to assist in the process of cross-referencing the national and international documents. The rationale used in tailoring shall be documented and retained as part of the S3 assessment file. Particularly, document the elimination of tests, reduction of sample quantities, or reduction of severities, any of which may result in reduced evidence to fully support the required safety assessment of the munition. Deviations from the S3 assessment testing program shall be approved by National S3 Authority(ies) or other appropriate Authorities prior to the start of testing. A tailoring example is provided in Appendix B, Annex 3 to show how test tailoring may be applied to an S3 Test Program based on a specific set of circumstances.

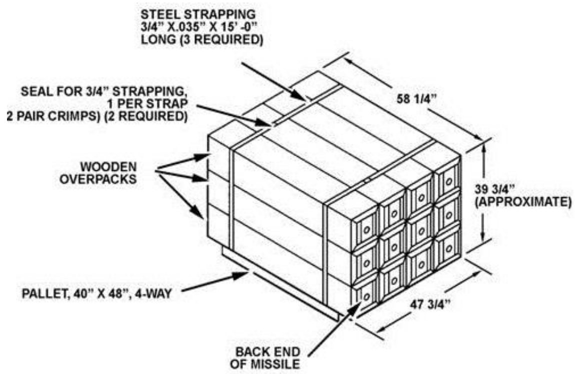
Reloadable Munitions with Packaging



Launch Tube with Installed Munition



Packaged Munition



Palletized Configuration

Figure 2. Packaging Configuration Examples.

6.4 Munition Packaging.

The munition test configuration should be tailored to the appropriate shipping, handling, storage, and operational deployment (stowage and launch) configuration that the munition will experience during its service life. Test items may be configured as palletized, stacked,

individual container, or bare munitions. Use the appropriate packaging configuration for the transport phase to be tested. Munition packaging used for S3 testing should have completed sufficient testing to ensure safe conduct of munition testing specified in this document. Figure 2 presents possible test item configuration examples.

6.5 Environmental Test Levels.

The environmental test levels specified in this document are based on the anticipated extreme conditions for storage, transportation, handling, maintenance, and firing of the munition. Natural and induced environmental factors for storage, transportation, and deployment are selected from AECTP 100, Annex A. Climatic test levels are based upon climatic categories defined in MIL-STD-810. Transportation dynamics test levels are based on MIL-STD-810, Method 514 and 516. The deployment (tactical) shock and vibration environments may be tailored based on measured data using tailoring guidance in MIL-STD-810. Electromagnetic Environmental Effects (E3) test levels are based on MIL-STD-464, JOTP-061, and JOTP-62. Alternative national or international test methods may only be used to meet the environmental test requirements if it can be demonstrated that the alternative is technically equivalent or superior to the referenced method; and following the guidelines in Paragraph 1 of this document. In addition, the international documents listed in the cross-reference table in Appendix I may also contain unique test requirements and severities only applicable to the specific nation. Rationale for the specific test levels in this document is provided in Appendix A. Test levels or specification deviations for munitions designated to be deployed to specific areas of the world or on specific transport or tactical vehicles may result in limitations on service use or require use of special procedures. Test time compression in accordance with MIL-STD-810 may be acceptable, however, the risk of introducing false failure modes should be considered.

6.6 Test Outline.

S3 assessment testing of shoulder launched munitions requires a series of sequential environmental tests, operating/firing tests, and non-sequential (stand-alone) environmental tests. The test flowcharts and munition allocation tables are shown in Appendix B in this document. These include sequential and combined environmental tests (i.e., vibration with temperature) to determine if the interaction (synergistic effect) and/or the sequence in which environments are experienced may result in a safety hazard.

6.7 Test Safety Considerations.

Explosive materials often become less stable with age. This ageing is exacerbated by the presence of increased temperature, humidity and vibration/mechanical stressing. It is therefore necessary to review the projected test sequence and determine whether the sequence, including any temperature conditioning and storage, result in an unacceptable hazard. As a minimum this will require an assessment of explosive material stability with respect to extreme temperature exposure durations. It might be necessary to divide the overall test time (shock and vibration in particular) into smaller portions to prevent heat build-up within the weapon and subsequent unintended energetic reaction. It is essential and mandatory to have a log for each weapon indicating the amount of time that has been spent at extreme temperature for the entire test sequence, including all periods of temperature conditioning.

6.8 Test Sample Quantities.

The test sample quantities are largely dictated by the minimum number of destructive tests (i.e., static firing, dynamic firings, breakdown test and critical analysis (BTCA), pressure vessel structural integrity tests, hazard classification, and insensitive munitions) to provide sufficient evidence of munition safety. Specific rationale for the quantities in each of the destructive test categories is provided in Appendix A. The following general notes should be considered when assessing the test sample quantities required for an S3 test program:

a. Materiel having more than one configuration, operating state, or operating platform may require increased test sample quantities.

b. Existing safety data may also be reviewed for acceptability. This may increase or decrease sample sizes and the number of tests. The degree to which this data can be used depends upon munition characteristics, reliability and completeness of the existing safety data, and the adequacy with which it treats hardware configuration, input stress, potential synergistic effects, types and severity of hazards, and the probability of hazard occurrences. However, tests which may interact with each other in a synergistic fashion (e.g., vibration/shock or vibration/climate) must not be removed from the sequence.

c. Additional munitions beyond those recommended in this document may be needed in the test program for baseline purposes and to replace items that become damaged during testing. Also, fully inert munitions may be required for pre-cursor testing (thermal and mechanical) to evaluate and certify test procedures, setups and fixtures. Completely functional inert munitions may also be required to perform powered Hazards of Electromagnetic Radiation to Ordnance (HERO) tests.

d. Completely functional munitions are only required for test assets designated for the dynamic firing tests. For all other test assets, non-safety critical components (e.g., tactical guidance and control sections) may be removed in order to reduce test cost. Any hardware that is removed should be replaced by mass simulants with thermal, structural, and dynamic characteristics similar to the tactical hardware.

e. Tailoring of Test Sample Quantities. The test sample quantities or configuration may be modified provided rationale is approved by the appropriate National S3 Authority(ies) or other appropriate Authorities. For example, the number of dynamically fired test items may be reduced if:

(1) Previous firing tests of worst case pre-stressed (i.e., previously exposed to the sequence of environmental stresses) and temperature conditioned munitions provide the required fuze arming test data. Data from the previous firing tests is required to be provided with the new S3 assessment file.

(2) The fuze arming tests are not applicable. For example, specific munition

classes may not contain a warhead such as trainers or kinetic energy munitions.

f. Tailoring of Reduced BTCA Test Sample Quantities. Reduced BTCA test flow sequences may allow for the redistribution and/or reduction of test assets. This is dependent upon the level of BTCA testing required by the National S3 Authority (ies) or other appropriate Authorities. Upon completion of reduced BTCA testing, the munition may be a complete, ready to use round which can be designated for component testing or dynamic firing. For example, chemical stabilizer depletion tests may only require small slivers (~5 grams) of propellant which can be obtained without extreme damage to the munition. Therefore, these rounds could be used to provide additional test data or to reduce the total sample quantity by replacing the dynamic fire or component test assets.

7. PRE- AND POST-TEST INSPECTIONS.

Perform inspections of the munitions as indicated in the sequential test flowcharts in Appendix B. Inspections are to be conducted in accordance with the inspection levels defined below. Perform the appropriate inspections, checks or disassembly before and after any non-destructive munition S3 test and when test exposure is considered to have affected the test item. Conduct radiographic and/or other non-destructive inspection of the test item to ascertain and document any external and internal conditions existing prior to, or resulting from testing. Safety mechanisms and devices shall remain in their safe condition. Non-destructive techniques utilized shall have the capability to accurately assess the condition of the safety critical components.

7.1 Initial (Baseline) Inspection.

An initial inspection should be conducted to verify conformance of the munition to the production representative build standard and to provide an assessment of the baseline condition for subsequent test inspections. In addition to the Level 1 and Level 2 examinations described in Paragraphs 7.2 and 7.3, initial inspections should include baseline photographs and the items listed below. Deviations from the build standard should be assessed by the appropriate authorities to determine that the asset(s) is satisfactory for the S3 test program.

a. Physical characteristics such as weight and all critical dimensions for the munition and packaging.

b. Manufacturer, manufacturer’s markings and lot/batch numbers for the munition and packaging.

c. Propellant manufacturer, type, and grain.

d. Payload manufacturer, type, and charge weight.

e. Materials of construction.

f. Packaged configuration and number of rounds per shipping container.

g. Software version embedded in munition, launcher, or command launch unit (CLU), where applicable.

7.2 Level 1 (Basic) Inspection.

Level 1 (Basic) consists of visual examination, built in test (BIT), and power checks, if appropriate. Visually inspect all test items to determine the following:

a. Condition of shipping container.

(1) Physical damage.

(2) State of pressurization, fluids, and seals.

(3) State of desiccant and humidity indicators.

(4) State of munition retention hardware.

(5) State of shock and temperature indicators.

(6) Electrical Earthing / Grounding device.

b. Condition of the munition or subsystem.

(1) Physical damage.

(2) Indication of seepage, leaks, or exudation.

(3) State of indicators.

(4) State of seals.

(5) State of safe and arming (S&A) devices and fuzes.

(6) Check connectors.

(7) Condition of exposed cables.

(8) BIT checks if appropriate.

(9) Inspection of health monitoring unit and data if applicable.

(10) Check state of internal power source(s), if applicable.

7.3 Level 2 (Intermediate) Inspection.

Level 2 (Intermediate) encompasses Level 1, but also consists of radiography and non-destructive examinations (e.g., ultrasonic, tomography, magnaflux, eddy current) of all

munitions and pyrotechnic devices. The examination facility should have the capability to conduct radiographic inspection at low temperature extremes within 15 minutes after removal from a cold conditioning chamber. Deviation from this should be recorded and accepted by the appropriate authority. Level 2 inspections should determine the following:

a. State of S&A devices and fuzes to include testing all accessible squibs with a certified low current circuit tester or squib meter and performing umbilical electrical tests to ensure the munition is safe for handling and continued testing.

b. Indications of structural damage.

c. Condition of the propulsion unit assembly to check for cracks, voids, slump, liner cracking/detachment, or any other failure modes identified during the preliminary design assessment. This inspection should be conducted at the low operating temperature.

d. Condition of the warhead assembly to check for cracks, voids, defective adhesion, exudation, or any other failure modes identified during the preliminary design assessment. This inspection should be conducted at the low operating temperature.

e. Movement of internal components.

7.4 Level 3 (Breakdown Test And Critical Analysis (Btca)) Inspection.

a. Level 3 (BTCA) encompasses Level 1 and 2, but also includes disassembly for internal inspection. This is typified by destructive inspection assessing the chemical (composition, hazard properties, etc.) and physical (tensile, hardness, etc.) properties of not just the explosive materials, but also of other critical engineering materials contained within the test item. The requirements in Appendix E encompass safety critical and energetic ageing matters.

b. Reduced BTCA is permitted in the Empirical Test Flow to eliminate most of the energetic material assessments described in paragraphs E.2-7.2 through E.2-7.6, with the exception that essential energetic material tests are required in accordance with E.2-7.2.b. The selected energetic material tests should be based on an assessment of the energetic material properties required to demonstrate safe transport and launch of the munition. For example, stabilizer concentrations should be measured for all double base propellants.

8. S3 TEST PROGRAM OVERVIEW.

Two approaches for S3 Testing, Analytical and Empirical, are presented in Appendix B. While both of these approaches provide satisfactory confidence in the S3 assessment of any munition type, there are inherent benefits in terms of cost and test efficiency that tend to associate the Analytical S3 Test Approach with large, complex munition systems and the Empirical S3 Test Approach with the smaller, less complex munition systems.

8.1 Analytical S3 Test Approach.

The Analytical S3 test approach, as shown in Figure 3, evaluates the munition condition following sequential environmental testing by dynamic firings, rocket motor firings, BTCA and component tests. This approach requires fewer test assets than the Empirical S3 approach and is generally applicable to more complex or expensive missile systems for which the increased cost of BTCA and component testing is typically offset by the reduced quantity and the reduced per unit cost of the test assets.

This approach requires the minimum number of assets since it provides the highest level of component level test data for all safety critical components. Note, non-safety critical components (e.g., guidance and control sections) may be removed from the munitions and replaced with structural mass simulants. The recommended sample quantities for the Analytical S3 test approach are shown in Appendix B, Annex 1, Tables B1-1 and B1-2 and illustrated in the test flowcharts in Appendix B, Annex 1, Figures B1-1 and B1-2.

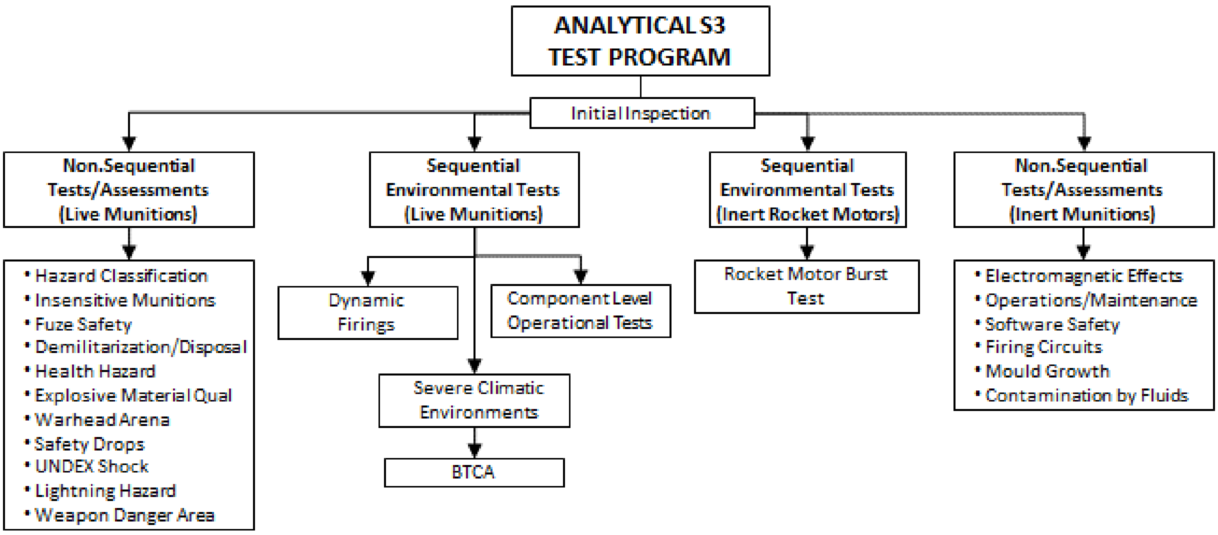


Figure 3. General S3 Test Flow for Shoulder Launched Munitions (Analytical Approach).

8.2 Empirical S3 Test Approach.

The Empirical S3 test approach, as shown in Figure 4, relies upon a combination of firing safety tests, static rocket motor firings, and a reduced BTCA for evaluation of the munition condition following sequential environmental testing. This approach requires more test assets than the Analytical S3 Test approach to establish the safety margin of the system. All test assets designated for firing safety tests are fully functional. For this reason, the Empirical S3 Test Approach is not typically associated with complex missile systems containing expensive, non-safety related components. Those assets supporting component testing shall be configured with all energetic materials but structural mass simulants may be utilized for those non-safety critical items (e.g., guidance and control systems) not required for component testing. The BTCA testing is a "reduced" requirement because confidence in system safety will be obtained by other means; e.g., more dynamic firings. See the guidance in paragraph 7.4.b. The recommended

sample quantities for the Empirical S3 test approach are shown in Appendix B, Annex 2, Tables B2-1 and B2-2 and illustrated in the test flowcharts in Appendix B, Annex 2, Figures B2-1 and B2-2.

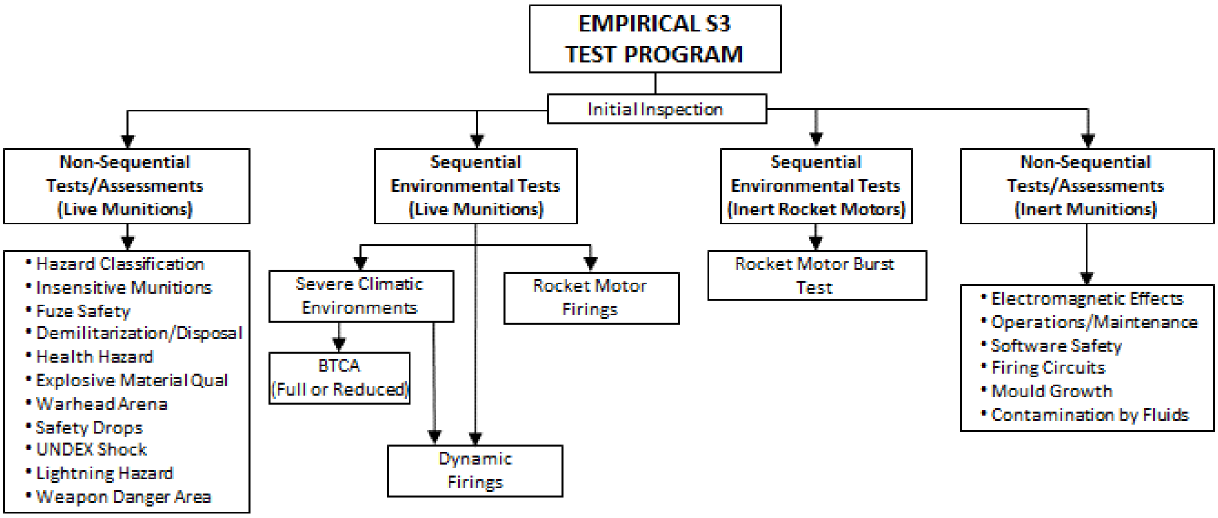


Figure 4. General S3 Test Flow for Shoulder Launched Munitions (Empirical Approach).

8.3 Environmental Tests.

Appendix C provides descriptions of the environmental tests required by the S3 test flows presented in Appendix B. Background and rationale for these tests are provided in Appendix A. An attempt has been made to address all environments described in Annex A of AECTP 100 based on the representative LCEP for shoulder launched munitions. Whenever possible, environmental test details are deferred to the MIL-STD-810 referenced in the sequential test procedures. For test methods which are not currently covered by MIL-STD-810, reference should be made to the appropriate International Test Operations Procedure (ITOP) or National document.

8.4 Operating Tests.

Appendix D provides descriptions of the firing safety and component level tests required on munitions that have undergone sequential environmental testing.

8.4.1 Firing Safety Tests (Unmanned Dynamic Firing).

Appendix D, Annex 1 describes the firing safety tests required for munitions that have undergone sequential environmental testing to evaluate firing safety (at motor ignition); munition operation, launch, and flight safety; warhead minimum arming distance; and firing

from enclosure. The unmanned firings are also used to evaluate the need for additional testing. Health hazard and Weapon Danger Area data should be acquired during dynamic firing tests as described in Appendix D. Validate and refine the analytical Weapon Danger Area models as described in paragraph 6.2.3. Background and rationale for these tests are provided in Appendix A, Annex 2.

8.4.2 Component Level Tests.

Appendix D, Annex 2 describes the component level tests required for munitions that have undergone sequential environmental testing. Component level assessment of energetic and pressure vessel components is required in order to estimate the probability and severity of failure during operational use. In addition to warheads and rocket motors, other items may require these tests. Examples are gas generators, pressure vessels, safe and arming devices, or thermal batteries which could present a hazard to personnel. Background and rationale for these tests are provided in Appendix A, Annex 2.

8.5 Additional Tests And Assessments.

Tests and assessments in addition to the environmental and operational testing described above are required as part of the S3 Package. In particular, Hazard Classification, Insensitive Munitions Assessment, and Munition Software System Safety Assessment are required but the details regarding the series of tests are not provided in this document since they are governed by other standards. References to the governing documents are provided below.

8.5.1 Munition Hazard Classification.

Appropriate munition hazard classification testing shall be conducted in accordance with Technical Bulletin (TB) 700-2.

8.5.2 Insensitive Munitions (IM) Assessment.

The IM assessment testing shall be conducted in accordance with MIL-STD-2105, STANAG 4439 and AOP-39. For a system expected to have significant changes to its vulnerability with age/use, using environmentally stressed munitions within IM vulnerability test and assessment should be considered.

8.5.3 Munition Software System Safety Assessment.

Munition software shall be designed, assessed and tested to assure its safety and suitability for service in accordance with ITOP 01-1-057 and Quadripartite Advisory Publication (QAP)-268.

8.5.4 Firing Circuits.

Conduct a full hazard assessment using Fault Tree Analysis (FTA), Failure Modes and Criticality Effects Analysis (FMECA), and sneak circuit analysis techniques and examine the firing system for adequacy of design and safety features and for compliance with specifications.

Use examinations and simulated firings to determine that firing switches and interlocks are located so as to protect against accidental firings and that firing circuit connections are protected against accidental grounding or shorting. Development testing should include tests to ensure the firing circuit acts as intended and that it will not fire when faults are introduced into the circuit.

8.5.5 Fuze Safety Testing.

The central objective of S3 of Fuzing Systems is to confirm and document that the fuzing system is safe and performs as intended in all expected service environments. The design safety requirements standard is MIL-STD-1316 and the fuze procedures document is MIL-STD-331.

8.5.6 Electromagnetic Environmental Effects (E3).

E3 assessment testing shall be conducted in accordance with MIL-STDs-464 and 461. This testing must address Hazards of Electromagnetic Radiation to Ordnance (HERO), Electromagnetic Compatibility (EMC), Electrostatic Discharge (ESD), Lightning Tests, and Firing Circuit Analysis that are required to demonstrate electrical safety. Minimum test asset quantities are provided in Appendix B. General guidance is provided in Appendix H, Annex 1.

8.5.7 Munition Demilitarisation and Disposal Assessment Testing.

Appropriate safety testing and analysis to assess the demilitarisation and disposal qualities of a munition shall be required in accordance with STANAG 4518.

8.5.8 Render Safe Procedure Testing.

Appropriate testing and analysis shall be performed to develop Explosive Ordnance Disposal (EOD) render safe procedures for new munitions entering the inventory.

8.5.9 Range Safety and Sustainability.

In accordance with AOP-15, appropriate testing and analysis shall be conducted to assess range safety and sustainability. The potential for individual and cumulative environmental effects of munitions use on operational ranges should be assessed (e.g., the expected deposition of hazardous substances, pollutants and contaminants, or emerging contaminants).

8.5.10 Explosive Materials Qualification Testing.

All explosive materials in a munition shall undergo appropriate testing and assessment per STANAG 4170 and AOP-7 to determine whether each possesses properties which make it safe for consideration for use in its intended role.

8.5.11 Health Hazards Testing.

Appendix H, Annex 2 describes the testing and analysis to assess potential health hazards posed

by the elements or combinations present in munitions and by munitions use.

8.5.12 Weapon System Launch Safety.

Appropriate testing and analysis shall be performed to assess launch safety for new munitions entering the inventory. Live fire testing will be required to provide sufficient evidence of safe operation and separation, launch/blast effects, and human factors associated with weapon system operation. For munitions intended for use in a reloadable launcher, this will include an assessment of launcher compatibility. At a minimum, these tests should encompass the dynamic firing objectives as described in Appendix A, Annex 2 (paragraph A.2-1.1), and the operations and maintenance (O&M) objectives as described in Appendix H, Annex 3. Although this document does not specifically govern S3 testing of reloadable launchers, general guidance and considerations for testing of reloadable launchers is included in Appendix B, Annex 4.

8.5.13 Operational and Maintenance Review.

Appendix H, Annex 3 describes the operational tests required to assess the safety of operational and maintenance procedures and equipment during field handling exercises.

8.5.14 Other Safety Tests to be Considered.

Appendix H, Annex 4 includes additional tests to be considered for inclusion in the S3 assessment. Consideration of these tests should be based on the anticipated LCEP, measured environments, or other environmental factors.

9. MUNITION SAFETY DATA PACKAGE.

As stated in JOTP-1 and AOP-15 Appendix C, the results of the testing and assessments required in this document will be compiled into a Munition Safety Data Package for use by the appropriate S3 approving authority in determining the overall S3 for shoulder launched munitions.

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APPENDIX A. BACKGROUND/RATIONALE

This document was developed within the international community and is written with references to both US and NATO test procedures to provide a framework for international procurement and test programs. Table I2-1 (Appendix I, Annex 2) provides cross reference of similar national and international test standards.

A1. INTRODUCTION.

This Annex provides background information and rationale for the sample quantities and test environments recommended by this document. Formal safety testing is required to establish test data, which supports the issuance of the safety certification. The tests may indicate that limitations or restrictions must be imposed when the safety certification is issued. These restrictions may be imposed to limit exposure to certain environments (climatic, dynamic, electromagnetic, etc.), to restrict methods of transportation, or to define special handling and operating procedures. Generally, because of increased severity associated with safety testing, satisfactory performance of the test item is not required. Poor performance after exposure to test environments may indicate a need for further investigation.

A2. SAMPLE QUANTITIES AND STATISTICAL CONSIDERATIONS.

The sample size recommendations of this document are based on prior tests of similar weapons and munitions, rather than strictly statistical considerations. Serious hazards such as warhead detonation or rocket motor burst at launch are observed as binomial (pass or fail) events, but the parameters that cause these events are unlikely to be so. For a simple binomial assessment, the predicted low failure rate coupled with a requirement for high statistical confidence, the sample sizes become very large, sometimes in excess of the eventual service population. This is not practical; therefore, other approaches are required in combination with statistical methods to estimate the residual safety margin based on measured parameters. For sequential environmental testing, confidence is built by ensuring the test environment provides the maximum feasible cumulative stress to the test items. Statistical methods are used to derive the test severities to ensure as far as practicable they envelope the predicted environment. However, as stated above, the final test quantities presented in this document are a compromise based upon the experience of a large international community of subject matter experts.

A2.1 Performance Test Data.

As described above, successful performance tests (component and munition level) with and without environmental exposure add confidence to the safety of the munition. Utilization of these data effectively increases the total number of samples.

A2.2 Increased-Severity Testing.

In order to yield acceptable confidence in safety test results with a relatively small sample size, increased-severity testing is prescribed in this document. The probability of munition failure resulting in a hazardous condition is increased by testing under conditions, which are representative of credible extremes or slightly above the environments to be encountered in actual munition use. These extreme environments are low-probability environments. Therefore, the test levels recommended in this document are at credible extremes. Rationale for the

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specific environments is presented in Annex 1 of this Appendix.

A2.3 Sequential and Combined Environments.

Munitions are subjected to environmental testing in a sequential manner, which is representative of the probable LCEP scenario. Testing in accordance with this life cycle sequence and combining environments (i.e., vibration with temperature) is recommended to determine if the interaction (synergistic effect) and/or the sequence in which environments are experienced may result in a safety hazard.

A2.4 Inspection For Incipient Failure.

For each test sample which fails during test, there are usually many that nearly fail. Detailed inspection of the test items before, during, and after test adds significantly to the confidence of the test data given the limited sample size. Radiographic inspections provide particularly useful insight into the condition of the munition including early detection of displaced components as well as cracking or debonding of energetic materials. Conditioning the munition to a cold temperature for the radiographic inspection enhances cracks in the energetic materials and provides for easier detection of defects. If the inspections indicate likely failure, further investigation or testing may be required. If the inspections indicate that a margin of safety exists (that no safety hazard is likely), the test can be declared complete. In either case, the data generated by conventional testing have been supplemented.

A2.5 Variable Test Data.

The use of measured variable data (pressure, force, strain, etc.) is recommended whenever practical. If margins of safety can be demonstrated between measured test data and measured or analytical failure modes, confidence in the test results are enhanced. If measured variable data indicate only small margins of safety exist, further investigation or testing may be required.

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APPENDIX A. BACKGROUND/RATIONALE.
ANNEX 1. ENVIRONMENTAL TESTS.

A.1-1 GENERAL.

A.1-1.1 LCEP.

During its expected life cycle, a munition will experience: 1) transportation from its place of manufacture to a storage facility, 2) transportation to a place of temporary storage in an operational theatre, 3) tactical transportation within that operational theatre, and finally 4) function or return to storage. At each stage it will experience various environments resulting from the local climate, general rough handling and transportation via numerous platforms. It may also experience abnormal environments such as being accidentally dropped.

A.1-1.2 Test Levels.

This Appendix gives rationales for the specific test procedures and test severities recommended in this document. The test levels are credible extreme environments, to which the inventory may be exposed as part of the LCEP. Conflicts between the recommended test levels and munition specific LCEP environments should be addressed through test tailoring and/or safety release restrictions.

A.1-1.3 Temperatures.

Shoulder launched munitions are required to remain safe and suitable for service at extreme temperatures where personnel are expected to be capable of military operations. It would be expected for the munitions to remain S3 during and following storage and transportation by various platforms within NATO climate categories C2 to A.1. The extreme temperatures of these climate categories (or the SRE for hot stream weapons) form the basis for the conditioning temperatures for all mechanical environment tests. Munitions are also expected to remain safe and suitable following storage at extreme cold conditions of a C3 climate category, but would not necessarily be expected to be moved during the coldest period within this climate zone due to difficulties with vehicles and the temperatures being outside the human comfort zone (i.e., survival as opposed to capable of military operations). For this reason, the cold temperature extreme for mechanical environmental tests have been based on the C2 climate category.

A.1-1.4 Temperature Stabilization.

For environmental tests that require temperature conditioning, temperature stabilization is achieved when the part of the item considered to have the longest thermal lag is changing no more than 2 °C per hour. Since it may not be practical to monitor the interior parts of a live munition with the longest thermal lag during test without damaging seals, the stabilization time may be determined prior to live munition testing using an instrumented thermally equivalent inert munition. The stabilization time will typically be required for the munition in both the unpackaged and the transport configurations and at the hot and cold temperature extremes. As an alternative, see Table A-1 for minimum stabilization time values. Care should be taken that no item exceeds the safe life of the energetic material when subjected to multiple exposures of high temperature conditioning.

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TABLE A-1. DEFAULT TEMPERATURE STABILIZATION TIMES

MUNITION DIAMETER (D) (CM)	CONFIGURATION	MINIMUM TEMPERATURE STABILIZATION TIME (HOURS)
D ≤ 12.7	Unpackaged	12
	Packaged/Palletized	24
D > 12.7	Unpackaged	24
	Packaged/Palletized	36

A.1-1.5 Solar Radiation Equivalent (SRE) Temperature.

As an alternative to installing solar lamps in a vibration test chamber, the solar radiation equivalent (SRE) temperature is specified in most mechanical environment tests in order to facilitate testing. The SRE is the maximum temperature value experienced by the energetic material (e.g., rocket motor propellant, warhead main charge) after exposure to direct or indirect solar radiation. Determination of this value will require exposure of an inert, internally instrumented munition, with similar thermal characteristics to the complete round, to the full solar test requirement defined in Appendix C, Annex 1, Paragraph C.1-5. The SRE temperature should be determined for both the packaged and unpackaged state, and applied for all mechanical environment tests such that the packaged SRE is used for packaged tests and the unpackaged SRE for the unpackaged tests. In the absence of this data, a value of +71 °C should be used in lieu of the SRE temperature since this reflects the maximum value of the A1 Storage and Transit diurnal cycle defined in MIL-STD-810.

A.1-2 CLIMATIC ENVIRONMENT TESTS (APPENDIX C, ANNEX 1).

Provided below are rationale for the climatic tests. Select the test item configuration (see Figure 2) that exposes the munition to the most severe environmental condition. For reloadable shoulder launched munitions, this is likely to be the unpackaged, bare munition configuration. Non-reloadable shoulder launched munitions are encased in a launch tube and packaged in an overpack shipping container. In this case, climatic testing would be conducted with the munition in the launch tube.

A.1-2.1 Humid Heat (Appendix C, Annex 1, Paragraph C.1-1).

The humid heat test is performed to determine the resistance of materiel to the effects of a warm humid atmosphere. Materiel may be exposed to this environment year-round in tropical areas and seasonally in mid-latitude areas. The procedure recommended by this document is an aggravated test. It does not reproduce naturally occurring or service-induced temperature-humidity scenarios. In order to reduce the time and cost of testing, the test item is exposed to higher temperature and humidity levels than those found in nature; however, the exposure duration is shorter. A minimum of ten test cycles has proven to be effective at inducing degradation/failures that are indicative of long-term effects. For test items incorporating seals

which protect moisture sensitive materials, longer test durations may be required to obtain a higher degree of confidence that the munition will remain S3 in warm-humid conditions.

A.1-2.2 Temperature Storage and Cycling (Appendix C, Annex 1, Paragraphs C.1-2 through C.1-4).

Low and high temperature testing is carried as part of the sequential trials program in order to induce thermo-mechanical stressing and accelerated ageing in the test munition.

A.1-2.2.1 Low Temperature Storage and Cycling (Appendix C, Annex 1, Paragraph C1.2).

The low-temperature storage test is intended to determine the effects of low-temperature storage on the munition. There is a 1 percent probability that munitions deployed in arctic areas (Category C3, MIL-STD-810) will be exposed to a temperature of -51°C. Category C3 applies to the coldest area of the North American continent and the areas surrounding the coldest parts of Siberia and Greenland. The low temperature can be expected to dwell once reached with no solar heating effects. A minimum of 3 days is recommended since this is considered sufficient duration to thermally stabilize the munition. If, however, other cold temperature degradation mechanisms are likely such as those related to constant strain at cold temperatures, then longer durations may be required and guidance should be sought from the munition designer. If the munition under test could be susceptible to thermo-mechanical stresses due to low temperature fluctuations, the C2 low temperature cycle or that defined in the LCEP should be used.

The low-temperature cycling test is intended to determine the effects of low-temperature operational environments on the munition (storage at extreme cold is addressed by the cold temperature storage test). The temperatures associated with the low-temperature cycling test are created by meteorological air temperatures (note that at this temperature extreme, the meteorological and induced diurnal cycles become aligned). The induced air temperature diurnal cycle (C2) for Category C storage and transit conditions given in MIL-STD-810, Method 502 is considered to adequately encompass most conceivable situations.

A.1-2.2.2 High Temperature Storage and Cycling (Appendix C, Annex 1, Paragraphs C.1-3 and C.1-4).

The high temperature cycling test is intended to determine the effects of thermo-mechanical stresses on the munition. The induced air temperature diurnal cycle for Category A1 storage and transit conditions given in MIL-STD-810, Method 501 is considered to adequately encompass most conceivable situations. For other environments, such as Naval controlled environments, other storage categories may be considered and are LCEP dependent.

The high temperature storage test is intended to accelerate chemical and physical based degradation mechanisms via a period of testing using a constant elevated temperature. A constant temperature of +71 °C is the maximum temperature that should be considered since this reflects the peak temperatures likely to be encountered during field storage or deployment in an A1 climate zone. Alternatively, a constant temperature of +58 °C may be more appropriate where the use of +71 °C is thought to generate unrealistic degradation.

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For most munitions 28 hot A1 induced diurnal cycles are considered sufficient to induce thermo-mechanical stressing representative of that which could occur in service. For chemical and/or physical ageing processes (e.g., stabilizer depletion or diffusion of chemical substances) longer durations are necessary to produce sufficient observable change; and 56 hot diurnal cycles have historically provided sufficient confidence to support an initial deployment of up to at least 6 months tactical storage. Chemical and physical processes may be simulated by constant temperature stressing, but care must be exercised since such stressing may induce unrepresentative failure modes or may not adequately exercise potential failure modes. Consideration must be given to the design of the munition and any design limitations. For example, gas cracking, phase changes or changes in the chemical reaction mechanism can occur during constant temperature ageing which may not occur during diurnal cycling or in service. This test should not be conducted instead of high temperature cycling, but may be used to supplement the chemical ageing effects of diurnal cycling tests. If the munition under test could be susceptible to high temperature fluctuations, then the A1 storage and transit (induced) cycle or that defined in the LCEP should be used.

If opting to substitute some of the hot diurnal cycles for fixed temperature stressing, only 28 of the 56 cycles should be substituted (with the remaining 28 cycles being applied along with the constant thermal stressing). Using the Arrhenius kinetic model discussed in AECTP 300 Method 306, Paragraph 2.4.2 ‘Test Duration’, and an activation energy of 70 kJ/mol; constant temperature stressing may be applied for 216 hours (9 days) at +71 °C, or 528 hours (22 days) at +58 °C where unrealistic degradation is anticipated at +71 °C.

It should be noted that laboratory based ageing studies using small samples of material do not take account of the geometry of the component and so some potential degradation mechanisms could be missed. Furthermore, it should be noted that the thermal ramp conditioning time should not be counted towards life estimates since it can prove difficult to determine the amount of thermal energy input to the munition. Therefore, it is difficult to model the equivalent ageing likely to have occurred within the munition.

Whatever ageing tests are conducted as part of the sequential trials program, the resulting predictions must be compared with the results of surveillance (ISS) to determine how accurate they were and whether any potential failure modes were missed.

A.1-2.3 Solar Radiation (Appendix C, Annex 1, Paragraph C.1-5).

This test is intended to aggravate those thermally induced degradation mechanisms associated with elevated skin temperatures and thermal gradients within the weapon, that are induced due to solar radiation. Since most Nations solar test chambers do not incorporate the ultraviolet element of the spectrum they tend not to aggravate the photo-chemical (actinic) degradation modes associated with solar radiation. If this is of concern (as may be the case for some paints, adhesives and polymers) then a separate ultra-violet exposure test will also be required. A minimum of seven A1 climate category cycles (meteorological temperature and solar radiation) is recommended in order to attain the maximum elevated temperatures throughout the test item. The solar radiation level of 1120 W/m^2 is derived from MIL-STD-810, Method 505.

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A.1-2.4 Thermal Shock (Appendix C, Annex 1, Paragraph C.1- 6).
This test is intended to simulate the rapid temperature transitions that are possible during logistic movements of munitions. Two possible approaches are described below. Examine the munition usage scenarios to determine the test item packaging configuration. If feasible, all testing should be carried out on unpackaged items to provide worst case thermal stress conditions. Stabilization at the temperature extremes is required.

A.1-2.4.1 Phased Thermal Shock.

A.1-2.4.1.1 Low Temperature Phase (Appendix C, Annex 1, Paragraph C.1-6a).

This test simulates movement of warm munitions from storage or from a transport vehicle in maintenance to an extreme cold environment or vice versa. The low temperature shock test consists of five temperature shock cycles between the temperatures of 21 °C (standard ambient) and -51 °C. In most applications, the munition will be exposed to the temperature shock environment in its logistic container. However, to address the most severe condition the munition should be tested in its unpackaged configuration.

a. The -51 °C temperature is the low extreme presented in MIL-STD-810, Method 503, for Climate Category C3.

b. Stabilization at the temperature extremes is required. Munitions in storage or in warm buildings associated with vehicle maintenance would likely achieve temperature stabilization. Also, the extremely low temperatures encountered in the natural environment are likely to persist longer than the munition temperature stabilization time.

A.1-2.4.1.2 High Temperature Phase (Appendix C, Annex 1, Paragraph C.1-6b).

This test exposes the munitions to rapid temperature transition from -5 °C (temperature at an altitude of 8 km, from MIL-STD-810, Method 503) to the unpackaged SRE temperature.

a. This test simulates rapid movement of munitions under the following scenarios:

   (1) Movement of warm munitions from storage (e.g., magazine or process area) to an extreme cold environment, or vice versa;

   (2) Rapid ascent from a desert airfield to high altitude (8 km) in an unheated aircraft compartment or carried externally.

   (3) Air delivery or airdrop from high altitude (8 km) to a desert environment.

b. Stabilization at the temperature extremes is required. Munitions in flight prior to air delivery would likely achieve temperature stabilization. Also, the extremely high temperatures encountered in the natural environment are likely

to persist longer than the munition temperature stabilization time.

A.1-2.4.2 Aggravated Thermal Shock.

a. The handling and transport of munitions between a temperature conditioned storage area and the ambient outdoor environment is the prevailing mechanism for rapid thermal change. This test does not simulate a specific transport scenario but it uses the rapid transition between the extreme temperature values to thermally stress the munition.

b. In this scenario, a single set of temperature shocks will be required. The temperature shock test consists of ten cycles from a cold extreme temperature of -51 °C to the high extreme temperature of no less than 71 °C. The transfer rate between chambers should be as fast as possible and is dependent upon munition portability requirements (i.e., man vs machine).

A.1-2.5 Immersion (Appendix C, Annex 1, Paragraph C.1-7).

a. Munitions may be exposed to water immersion during fording. The immersion test determines if the ingress of water affects materials and safe operation of the munition. This test requires temperature conditioning of the munition to establish a pressure differential (on cooling) to determine whether the seals or gaskets leak under relatively low pressure differential, and to induce expansion/contraction of materials. Temperature conditioning the item to 27 °C above the water temperature represents exposure to solar heating immediately prior to immersion. Thirty minutes of immersion at a depth of one metre is typically required, although there may be non-routine operational requirements to assess immersion in deep water, such as for combat swimmers, which necessitates immersion testing at higher pressures and for longer durations.

A.1-2.6 Salt Fog (Appendix C, Annex 1, Paragraph C.1-8).

a. The salt fog test (MIL-STD-810, Method 509) provides a set of repeatable conditions to determine the relative resistance of the munition to the effects of an aqueous salt atmosphere. This test locates potential problem areas, quality control deficiencies, design flaws, etc., in a relatively short period of time and is required for munitions that will experience significant exposure (as opposed to infrequent or irregular) to high levels of salt in the atmosphere. It should be noted that testing at the component level will not address galvanic corrosion.

b. As a minimum, this JOTP requires two cycles of alternating wet-dry-wet-dry conditions of 24 hours each to be imposed. Experience has shown that alternating periods of salt fog exposure and drying conditions provides a more realistic exposure and a higher damage potential than does continuous exposure to a salt atmosphere. The munition is tested in the most vulnerable configuration (packaged or unpackaged) as identified in the LCEP. The number of cycles may

be increased if a higher degree of confidence is required to assess the ability of the materials involved to withstand a corrosive environment (e.g., sea based munitions stored above deck may require additional cycles). Note, there is no relationship between this test and any real world exposure duration but it does provide an indication of potential problem areas associated with the salt (maritime) environment, nearby water sources, and from salted roads during winter operations.

A.1-2.7 Sand and Dust (Appendix C, Annex 1, Paragraph C.1-9).

a. The sand and dust test (MIL-STD-810, Method 510) determines the effects on munitions after exposure to dust and sand laden atmospheres. Dust consists of particle sizes less than 150 microns. Sand has particle sizes greater than or equal to 150 microns.

b. Munitions may be exposed to sand and dust environments on a worldwide basis. The greatest exposure would be expected during operations in desert regions due to vehicle convoys and aircraft/helicopter movements. The movement of military vehicles in hot dry desert regions or in areas where the surface is liable to break up into small particulate is liable to result in dust and sand-laden atmospheres. Munitions may also be transported by personnel during operation of aircraft on airfields and are likely to be directly subjected to artificially blown dust and sand. Material deposited inside the munition may cause short-circuiting, build-up of static electricity, interference between moving parts, and contamination of any lubrication systems. This JOTP requires the munition to be tested in the most severe deployment configuration using the most severe exposure parameters defined in Procedures I and II of Method 510.

A.1-2.8 Rain/Watertightness (Appendix C, Annex 1, Paragraph C.1-10).

The rain test (MIL-STD-810, Method 506, Procedure 1) recommends using a 100 ± 20 mm/hr severity for a duration of two hours. This severity is considered adequate to address exposure throughout most of the world apart from tropical zones where rainfall rates can be much higher. If deployment to tropical zones is anticipated then the munition should probably be subjected to the higher severity of 200 ± 50 mm/hr. However, it should also be considered whether the munition will actually be fielded during a tropical rainstorm. If not then the ‘typical’ worldwide severity would be adequate. This JOTP requires the munition to be tested in the most severe transport configuration as determined by the LCEP. The wind speed of 18 m/s is consistent with MIL-STD-810, Method 506, Procedure 1.

A.1-2.9 Icing (Appendix C, Annex 1, Paragraph C.1-11).

Munitions are likely to be exposed to severe icing in cold climates. The icing test (MIL-STD-810, Method 521) determines the potential damaging effects of icing on the munition where stresses are imposed at joints and interfaces of adjacent parts. Damage may also be incurred as a result of the methods used to remove the ice and the subsequent accumulation of moisture

after melting of the ice. The principal sources of ice are frosting, freezing rain, refreezing of thawing snow, and freezing of condensation. The thickness of the ice deposited on the item depends upon the duration of the exposure and the contours of the munition. Medium ice loading conditions are required by this JOTP with the munition being in the most severe deployment configuration as determined by the LCEP.

A.1-2.10 Low Pressure (Altitude) (Appendix C, Annex 1, Paragraph C.1-12).

Transport aircraft cargo compartment pressure conditions are based upon the anticipated deployment or flight profile. Compartments normally pressurized may not be in certain situations. There are many different types of cargo transport aircraft on which materiel could be transported, and many different types of pressurization systems. Most pressurization systems provide outside atmospheric pressure in the cargo compartment (no pressure differential between the inside and outside of the aircraft) up to a particular altitude, and then maintain a specific pressure above that altitude. The pressure inside the cargo department is known as "cabin altitude". Subject the munitions to the most likely anticipated conditions. For storage/air transport use MIL-STD-810, Method 500, Procedure 1; and unless otherwise identified, use 4,572 m (15,000 ft) for the cabin altitude (corresponding pressure in a standard atmosphere: 57 kPa or 8.3 psia). Other conditions may be applicable for munitions that have been designed for transport on a particular aircraft with unique cabin altitude requirements.

A.1-2.11 Cargo Aircraft Decompression (Appendix H, Annex 4, Paragraph H.4-9).

Rapid decompression can result when cabin pressurization is lost during an accident scenario in a transport aircraft. Rapid decompression may result in bursting of the munition container and this test is required to verify that the packaging does not present a secondary hazard to the munition or aircraft crew. This test should be conducted as part of packaging certification for air transportation and is not necessarily required for munition safety testing. However, munition seals and some fluid filled munition components may be susceptible to sudden changes in pressure if the container fails to regulate the pressure in a rapid decompression scenario. If the results of the container rapid decompression test or the munition altitude test indicate a potential vulnerability, this test should be conducted on the packaged munitions.

A.1-2.12 Mold Growth (Fungus and Biological Hazards) (Appendix C, Annex 1, Paragraph C.1-13).

Microbial deterioration is a function of temperature and humidity and is an inseparable condition of hot-humid tropics and the mid-latitudes. MIL-STD-810, Method 508 is used to determine if mold growth will occur and, if so, how it may degrade/impact the use of the munition. Twenty-eight days is the minimum test period to allow for mold germination, breakdown of carbon-containing molecules, and degradation of material. This is a non-sequential test and may be conducted on leftover components or material samples.

A.1-2.13 Contamination by Fluids (Appendix C, Annex 1, Paragraph C.1-14).

Contamination of the munition may arise from exposure to fuels, hydraulic fluids, lubricating

oils, solvents and cleaning fluids, de-icing and anti-freeze fluids, insecticides, sunblock, disinfectants, coolant dielectric fluid, and fire extinguishants. Select the fluids most commonly encountered throughout the munitions life cycle and apply to the item in the most severe deployment configuration as determined by the LCEP. Use the intermittent exposure method described in MIL-STD-810, Method 504. Contamination effects must be analyzed for its immediate or potential (long term) effects on the proper functioning of the munition.

A.1-3 MECHANICAL ENVIRONMENT TESTS (APPENDIX C, ANNEX 2).

Provided below are the rationale for the dynamic environments likely to result from normal usage in severe environmental conditions, or from plausible mishandling during logistic and field operations. The weapons should be tested following temperature conditioning at either the SRE temperature (packaged or unpackaged as appropriate for the test configuration) for the hot weapons and -46 °C for the cold weapons (rationale given at Annex 1, paragraphs A.1-1.3 and A.1-1.5).

A.1-3.1 Logistic Transportation Dynamics.

Shoulder launched munitions may be logistically transported by commercial and/or military vehicles. Life-cycle distances for each mode of transport are specified in AECTP 100. Each of these environments must be addressed as applicable. However, S3 testing may not require full life-cycle distances. The required distance for S3 testing may be based on the number of expected deployments. Table A-2 is an example of the logistic land transportation dynamics requirements in the current versions of AECTP 100 and MIL-STD-810, Method 514, but with test requirements based on a single deployment scenario. These test requirements (i.e., distance and time) should be multiplied by the number of expected deployments considered necessary to meet the S3 test program requirements. The National S3 Authority(ies) or other appropriate Authorities shall approve of the requirements prior to the start of testing.

A.1-3.1.1 Logistic Land Transportation Dynamics (Commercial).

A.1-3.1.1.1 Logistic Wheeled Vehicle Transportation Dynamics (Appendix C, Annex 2, Paragraph C.2-1.1).

The movement of packaged materiel from the point of manufacture to the storage location is usually accomplished by commercial logistic vehicles over improved or paved highways. This can be addressed by the ‘Ground Wheeled Common Carrier’ vibration profiles in MIL-STD-810, Method 514. No factors of safety need to be applied to the amplitude since MIL-STD-810, Method 514 vibration schedules are specified. These vibration schedules have been developed from field data and have conservatism factors built into them. Common Carrier vibration should be applied for a duration equivalent to the distances shown below in Table A-2. This is the first test to be performed in the munition life cycle test sequences of Appendix B. The intent is to degrade the shipping container and weapon seals prior to the climatic environmental tests.

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TABLE A-2. LAND TRANSPORTATION TEST DURATION EXAMPLES BASED ON AECTPS 100-4 AND MIL-STD-810G/CN1, METHOD 514

DEPLOYMENT PHASE	AECTP 100-4 LAND TRANSPORT DISTANCE (LIFETIME)[1]	TRANSPORT MODE	DEFAULT DISTANCES FOR SINGLE DEPLOYMENT	MIL-STD-810G/CN1, METHOD 514, TEST RELATION TO FIELD EXPOSURE[3]	JOTP-10 MINIMUM TEST DURATIONS[2]
Logistic (Commercial Vehicle)	10,000 km	Secured Cargo – Common Carrier (packaged or palletized)	4,800 km	Vibration: Vertical Axis 1hr/axis = 4000 km Longitudinal and Transverse Axes 1hr/axis = 1609 km	Vert: 72 min/axis Long/Trans: 179 min/axis
				Number of Restrained Cargo Shocks to be equivalent to 4,800km	No requirement if military wheeled vehicle transport shocks are performed.
Logistic (Military Vehicle)	10,000 km	Secured Cargo – Common Carrier (packaged)	4800 km	Vibration: Vertical Axis 1hr/axis = 4000 km Longitudinal and Transverse Axes: 1hr/axis = 1609 km	Vert: 72 min/axis Long/Trans: 179 min/axis
		Secured Cargo – Tactical Wheeled Vehicle (includes four wheeled trailers) (packaged)	800 km	Vibration: All Axes 40 min/axis = 805 km	40 min/axis
				Number of Restrained Cargo Shocks in Table C2-1 = 800 km	No requirement for packaged if conducted on unpackaged rounds.
		Two Wheeled Trailer[4] (packaged)	50 km	Vibration: All Axes: 32 min/axis = 52 km	32 min/axis
Tactical Deployment	5,000 km	Secured Cargo – Tactical Wheeled Vehicle (includes 4 wheeled trailer) (deployed transport configuration)	800 km	Vibration: All Axes: 40 min/axis = 805 km	40 min/axis
				Number of Restrained Cargo Shocks in Table C2-1 = 800 km	See Table C2-1
		Two Wheeled Trailer (deployed transport configuration)	50 km	Vibration: All Axes: 32 min/axis = 52 km	32 min/axis
		Secured Cargo – Tracked Vehicle (deployed transport configuration)	500 km	Vibration: All Axes: 45 min/axis = 160 km	140 min/axis
		Loose Cargo (deployed transport configuration)	250 km	20 min/axis= 240 km	20 min

*See notes on next page.

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NOTE 1: AECTP 100-4 distances are provided as examples only and reflect potential cumulative life distances. Use the most current AECTP 100 values.

NOTE 2: JOTP-10 minimum test requirements reflects the distances likely to be experienced during one deployment cycle. For multiple deployments, additional mileage may be added as determined by the munition LCEP. In some cases, a follow-on surveillance program will address a multiple deployment scenario.

NOTE 3: MIL-STD-810G/CN1, Method 514 time/distance relationships are provided as examples only. Use the most current MIL-STD-810 values.

A.1-3.1.1.2 Packaged Transit Drop (Appendix C, Annex 2, Paragraph C.2-1.2).

The packaged transit drop test simulates accidental drops encountered in logistical (packaged) handling of the munitions such as a hovering helicopter dropping the munitions from a sling or the unloading of munitions stacked on a truck. The munitions could be transported in either the single munition or bulk munition (palletized) configuration. All S3 test assets in the sequential environmental test flow are exposed to the Packaged Transit Drops. Shoulder launched munitions dropped from these heights are typically expected to remain safe for use.

a. The recommended drop height of 2.1 meters is based on the likelihood of a shoulder launched munition being expected to fire safely following a drop, in the shipping container, from the bed of a transport vehicle. If a worst case scenario is identified that exceeds the recommended 2.1 meters, that height may be used for this test. However, the drop test height should be no less than the recommended 2.1 meters.

b. It is not expected that a shoulder launched munition would be dropped more than once from this height during its service life. However, as a worst case scenario, two drops are required for the 2.1 meter packaged drop. Justification may be provided to reduce this requirement to one drop if it is expected that unacceptable damage will result from more than one 2.1 meter drop.

c. Drop heights and/or orientations may be tailored taking due account of the fragility of the munition to be tested, with the tailoring rationale being documented in the S3 Safety Data Package. The tailored drop height and/or orientation represents the maximum severity the munition can survive to remain safe for use. This munition specific drop height and/or orientation will be documented in the Field Maintenance/Technical Manuals. If a munition exceeds the aforementioned drop specifications, removal of this individual munition from service will be required for further assessment or disposal.

A.1-3.1.1.3 Logistic Rail Transportation Dynamics (Appendix C, Annex 2, Paragraph C.2-1.3).

a. Rail transport vibration would normally be conducted in accordance with MIL-STD-810, Method 514. Based on an assessment that this environment is relatively benign compared to other S3 test environments, this test was eliminated as a requirement for

shoulder launched munitions. Although not required for S3, this test may be required for US military transportation certification.

b. Rail impact testing would normally be conducted in accordance with MIL-STD-810, Method 526. Based on an assessment that this environment is relatively benign compared to other S3 test environments, this test was eliminated as a requirement for shoulder launched munitions. Although not required for S3, this test may be required for US military transportation certification. Inert assets with similar mass and structural characteristics are typically acceptable for transportation certification.

A.1-3.1.2 Logistic Transport Dynamics (Military).

Military transportation for shoulder launched munitions can be subdivided to address military logistic and tactical movements. Logistic movement includes transportation from a point of entry into the theatre of operations to an airfield storage site, forward operating base, or naval vessel. These movements may include land, sea, and air transportation on military vehicles with the munition packaged in the transport container. Tactical movement addresses transportation beyond the forward supply point and the munition may be either packaged or unpackaged.

A.1-3.1.2.1 Military Land Transportation Dynamics.

Military land vehicle transportation from a point of arrival into the theatre of operations up to a storage area may be as secured cargo on wheeled vehicles, trailers, and/or tracked vehicles. Shoulder launched munitions are likely to be deployed to forward operating bases which requires transportation on degraded roads. Vehicle vibration and restrained cargo shock environments must be addressed.

A.1-3.1.2.1.1 Military Wheeled Vehicle Dynamics (Appendix C, Annex 2, Paragraphs C.2-2.1 and C.2-2.2).

a. Military land transportation as secured cargo on wheeled vehicles consists of both vibration and shock elements that require individual tests to fully address the environment. Furthermore, military land transportation may incorporate aspects of both on- and off-road movement. The vibration element of this environment can be addressed by the profiles in MIL-STD-810, Method 514 for a ‘Tactical Wheeled Vehicle’ using a duration equivalent to distances shown in Table A-2. Since a mission profile, incorporating both on- and off-road movement, was considered during development of the tactical wheeled vehicle vibration spectra there is no requirement for separate tests to address these two aspects of the environment.

b. Some weapon systems require special military transport vehicles. These vehicles most likely are not addressed in the MIL-STD-810, Method 514 ‘Tactical Wheeled Vehicle’ vibration test schedule. In this case tailored test specifications need to be developed based upon measured field data.

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c. Restrained cargo shock testing is required to address minor obstacle negotiation for wheeled vehicles, particularly those travelling in an off-road role. The environment must be conducted in order to meet the dynamic test requirements and individual elements cannot be tailored out. The Restrained Cargo Transport Shock levels are based on MIL-STD-810, Method 516.

d. These tests should be conducted in the configuration identified in the LCEP for this mode of transportation. See Table A-2 for an example of transport distance and test duration. Tailor the tests accordingly.

A.1-3.1.2.1.2 Two Wheeled Trailer Vibration (Appendix C, Annex 2, Paragraph C.2-2.3).

Two wheeled trailers are commonly used to transport shoulder launched munitions. The environment can be addressed by the vibration profiles in MIL-STD-810, Method 514 for ‘Two Wheeled Trailer’.

A.1-3.1.2.1.3 Tracked Vehicle Transportation Vibration (Appendix C, Annex 2, Paragraph C.2-2.4).

Transport of shoulder launched munitions by a tracked vehicle is a possible transport mode. This environment can be addressed by the vibration profiles in MIL-STD-810, Method 514 for ‘Materiel Transported as Secure Cargo’ using a duration equivalent to the distance specified in the LCEP. Typically, the shock aspects associated with this environment are addressed by other tests in the sequence so there is no requirement to address these specifically.

A.1-3.1.2.1.4 Loose Cargo Repetitive Shock (Appendix H, Annex 4, Paragraph H.4-10).

Transportation of shoulder launched munitions as loose, or unsecured, cargo is possible and testing is required within the environmental sequence. Test in accordance with MIL-STD-810, Method 514. Since no overall distance is specified in AECTP 100, the default of 20 minutes testing time as per MIL-STD-810, Method 514 is sufficient for most applications.

A.1-3.1.2.2 Military Sea Transportation Dynamics.

A.1-3.1.2.2.1 Shipboard Vibration (Appendix C, Annex 2, Paragraph C.2-3.1).

For transportation of shoulder launched munitions by military ships, vibration testing is not normally required since this environment tends to be relatively benign compared to other vibration environments within the LCEP. If required, the test should be conducted in accordance with MIL-STD-810, Method 528.

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A.1-3.1.2.2.2 Shipboard Shock (Underwater Explosion) (Appendix C, Annex 2, Paragraph C.2-3.2).

The shocks likely to occur during non-contact underwater explosion (UNDEX) cause significant shock amplitudes that exceed those from normal handling. UNDEX shock testing in accordance with MIL-S-901 or appropriate International Standards is a mandatory requirement prior to ship embarkation for some NATO Nations and cannot be tailored out. The overall basis for UNDEX shock is addressed in Allied Navy Engineering Publication (ANEP) 43. Additional guidance may be found in STANAGs 4549 and 4150. The temperature in the ship's hold would be expected to be relatively benign, so testing may be performed under standard ambient conditions (+21 °C). The typical requirement would be for the munitions to remain 'Safe for Disposal' so testing may be conducted non-sequentially. If, however, the requirement is for the munitions to remain 'Safe for Use' (as may be necessary for Naval application) UNDEX shock testing must be conducted within the sequence.

A.1-3.1.2.3 Military Air Transportation Dynamics.

Shoulder launched munitions may be subjected to Military Air transportation by either fixed wing transport aircraft (jet and propeller) or helicopters as determined by the LCEP. Distances for each mode of transport are specified in AECTP 100. Each of these environments must be addressed as applicable.

Table A-3 summarizes the military air transportation dynamics requirements as an example based on the current versions of AECTP 100 and MIL-STD-810.

TABLE A-3. AIRCRAFT CARGO TRANSPORTATION TEST DURATION EXAMPLES BASED ON AECTPS 100-4 AND MIL-STD-810G/CN1

TRANSPORT MODE	AECTP 100-4[1] FLIGHT DURATIONS FOR LAND VEHICLE AND NAVAL MUNITIONS	MIL-STD-810G/CN1[2] TEST RELATION TO FIELD EXPOSURE	JOTP-10 TEST DURATIONS
Fixed Wing Cargo Jet	100 hours	1 min/takeoff (10 hr flight/takeoff)	10 min/axis
Fixed Wing Cargo Turboprop	100 hours	1 hr/axis (no equivalence)	1 hr/axis
Helicopter Internal Cargo	10 hours	1 hr/axis = 6 hrs flight	1.5 hrs/axis

NOTE 1: AECTP 100-4 Distances provided as examples only. The most current AECTP 100 values should be applied.

NOTE 2: MIL-STD-810G/CN1 Time/Distance Relations provided as examples only. The most current MIL-STD-810 values should be applied.

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A.1-3.1.2.3.1 Fixed Wing Turboprop Aircraft Vibration (Appendix C, Annex 2, Paragraph C.2-4.1.1).

The most common propeller cargo aircraft used throughout NATO is the C130, of which the four and six bladed propeller variants are most typical (4-blade, f_0=68 Hz and 6-blade, f_0=102 Hz). The vibration severities for these aircraft are defined in MIL-STD-810, Method 514, for 'Propeller Aircraft'. If other cargo aircraft are identified as part of the LCEP, then the blade frequencies (f_0) for these shall also require consideration. Since it is not always possible to predetermine the specific aircraft types that will be used during transportation, the total test duration based on the total flight duration defined in AECTP 100, Annex E, Annex 1 for each commodity type transported by 'Propeller Aircraft' should be split between the different blade frequencies (f_0) identified. For C130, this will require the test to be divided equally between the two blade frequencies (f_0 = 68 Hz and 102 Hz) as a minimum.

A.1-3.1.2.3.2 Fixed Wing Jet Aircraft Vibration (Appendix C, Annex 2, Paragraph C.2-4.1.2).

The vibration environment associated with cruise is largely addressed by other vibration environments within the LCEP and need not necessarily be tested. The take-off vibration environment is significantly more severe than that for cruise, and can be addressed by the vibration profiles in MIL-STD-810, Method 514 for 'Jet Aircraft Cargo – Takeoff'. The duration of this test is determined based on the number of takeoff events. The number of takeoff events in the life of a munition may be estimated from the total flight duration defined in AECTP 100, Annex E, Annex 1, for each commodity type transported by 'Jet Aircraft' divided by an assumed average flight duration of 10 hours per flight.

A.1-3.1.2.3.3 Helicopter Cargo Transportation Vibration (Appendix C, Annex 2, Paragraph C.2-4.2).

Shoulder launched munitions may be transported by a variety of helicopters as part of its LCEP. Common cargo helicopter types used throughout NATO can be grouped according to their fundamental blade frequencies as per Table A-4. The vibration environment for these cargo helicopters can be addressed by the vibration profiles in MIL-STD-810, Method 514 for 'General' materiel. If other cargo helicopters are identified as part of the LCEP, then the blade passage frequencies for these shall also require consideration but only if they are sufficiently different to the 11 Hz, 17 Hz, and 21 Hz already identified. Since it is not always possible to predetermine the specific aircraft types that will be used during transportation, the total test duration based on the total flight duration defined in AECTP 100, Annex E, Annex 1 for each commodity type transported by 'Helicopter' should be split between the different helicopter types identified. To be consistent with NATO AECTP 400 Method 401, helicopter cargo transportation should be conducted for a total of 1.5 hours per axis to represent the 10 hrs of helicopter flight. This duration should be divided evenly between the blade frequency groups in Table A-4. Modify the default sine and random vibration amplitudes specified in MIL-STD-810, Method 514 from the default operational life (currently 2500 hrs) to the recommended test duration using the equivalent fatigue guidance provided in MIL-STD-810 Method 514. Note that the 100,000 cycle minimum test duration in the current MIL-STD-810 guidance is not applicable to the individual deployment requirement described above.

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TABLE A-4. HELICOPTER MAIN ROTOR PARAMETERS

HELICOPTER	MAIN ROTOR			
	ROTATION SPEED, HZ	NUMBER OF BLADES	BLADE PASSAGE FREQUENCY, HZ	BLADE PASSAGE FREQUENCY, HZ, FOR S3 TESTING
UH-1 (Huey)	5.40	2	10.80	11 Hz
CH-47D (Chinook)	3.75	3	11.25	
CH-46 (Sea Knight)	4.40	3	13.20	
UH-60 (Black Hawk)	4.30	4	17.20	17 Hz
Sea King / Commando	3.48	5	17.40	
Puma	4.42	4	17.68	
EH101 (Merlin)	3.57	5	17.85	
NH-90	4.26	4	17.04	
CH-53E (Super Stallion)	3.00	7	21.00	21 Hz

A.1-3.1.2.3.4 Parachute Delivery.

A.1-3.1.2.3.4.1 Low Velocity Parachute Drop (Appendix H, Annex 4, Paragraph H.4-6).

Shoulder launched munitions are likely to be re-supplied by parachute delivery and are expected to remain S3 following such an event. Low velocity parachute delivery typically results in impact velocities of 9.2 m/s (30 ft/sec). This environment may be replicated by either an aircraft drop per ITOP 07-2-509 or may be simulated with a 4.3 m (14 ft) freefall drop unless specific and validated evidence is presented to the contrary. This freefall drop value is consistent with AOP-20 and MIL-STD-810G. If it can be demonstrated that the shock loads to the munition in parachute drop are less severe in terms of velocity and spectral content to the 2.1 m transit drop, the parachute drop may be eliminated as a S3 test requirement.

A.1-3.1.2.3.4.2 High Velocity Parachute Drop (Appendix H, Annex 4, Paragraph H.4-7).

Munitions that may be re-supplied by high-velocity parachute delivery are expected to remain S3 following such an event. High velocity parachute systems may result in impact velocities of 27.3 m/s (90 ft/sec). This environment may be replicated by either an aircraft drop per ITOP 07-2-509 or may be simulated with a 38.1 m (125 ft) freefall drop unless specific and validated evidence is presented to the contrary. This test should be conducted as a non-sequential test on a minimum of three munitions.

A.1-3.1.2.3.4.3 Malfunctioning Parachute Drop (Appendix H, Annex 4, Paragraph H.4-8).

Munitions that may be re-supplied by parachute delivery are at risk of a malfunctioning parachute drop scenario and are expected to remain safe for disposal after such an event. Per AOP-20, test E5, malfunctioning parachute systems may result in impact velocities of 45.7 m/s (150 ft/sec). This environment may be replicated by either an aircraft drop per ITOP 07-2-509 or may be simulated with a 116 m (380 ft) freefall drop unless specific and validated evidence is presented to the contrary. This test should be conducted as a non-sequential test.

APPENDIX A. BACKGROUND/RATIONALE.
ANNEX 1. ENVIRONMENTAL TESTS.

A.1-3.2 Tactical Drop/Impact (Appendix C, Annex 2, Paragraph C.2-5).

The Tactical Drop test simulates accidental drops encountered during handling of munitions when subjected to maintenance and/or (un)loading from vehicles. For the latter, the munition will be in its launch configuration such as bare munition or canistered as described in paragraph 6.4 of the main text. The drop heights used are tailored according to the LCEP, but it is recommended that these should be no less than 1.5 m for shoulder launched munitions. The munition should remain safe to fire after dropping. It is not expected that the munition would be dropped more than once during its service life so only one drop test is considered necessary per orientation. Drop heights may be tailored taking due account of the fragility of the munition, with the tailoring rationale being documented in the S3 Safety Data Package; and the reduced drop height limitation documented in the Field Maintenance/Technical Manuals to require removal of the munition from service if dropped higher than the test heights.

A.1-3.3 12-Metre Logistic Drop (Appendix C, Annex 2, Paragraph C.2-6).

This mandatory logistic drop test, as described in MIL-STD-2015, assesses the safety of the weapon when exposed to a free-fall drop which may be encountered during ship loading operations. This test is conducted as a non-sequential test since it is representing an accident scenario with no expectation for the munition to remain safe for use. The 12-metre logistic safety drop test is required in the unpackaged configuration for any munition handled out of the shipping container on a naval vessel. In most cases, the munition will be tested in the packaged configuration. For either configuration, the drop height of 12-metres should not be tailored.

A.1-3.4 Munition Flight Dynamics.

Shoulder launched missiles and rockets may experience high shock levels during rocket motor ignition and significant vibration levels during free flight. Appropriate functional tests may be conducted during these environments to ensure all safety critical components are functional at the system level. Since both the Analytical and Empirical test flows require some quantity of dynamic firings, the munition flight dynamic environments will be sufficiently addressed. If dynamic firings are not conducted, laboratory based munition flight dynamics will be required.

A.1-3.4.1 Launch Shock.

If required, launch shock should be conducted in accordance with MIL-STD-810, Method 516 and 525; however, tailored test levels based on measured data will normally be used. Test severities should be derived in accordance with MIL-STD-810, Method 516.

A.1-3.4.2 Free Flight Vibration.

If required, free flight vibration testing should be conducted in accordance with MIL-STD-810, Method 514 and 525; however, tailored test levels based on measured data will normally be used. Test severities should be derived in accordance with MIL-STD-810, Method 514.

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APPENDIX A. BACKGROUND/RATIONALE.
ANNEX 2. OPERATING TESTS.

A.2-1 FIRING SAFETY TESTS (APPENDIX D, ANNEX 1).

Firing tests are conducted to determine firing safety related to munition operation, launch, and flight. These tests are conducted at both high and low temperature conditions. The high temperature tests should be conducted at the higher of 63 °C or the SRE temperature. The cold temperature tests should be conducted at -46 °C. Although these values may be more severe than the manufacturer's recommended upper and lower firing temperatures for munition performance, the extreme values should be used to assess safety aspects of the motor firing under worst case service conditions. Appropriate precautions should be taken if the firing temperature exceeds the manufacturer recommendations.

A.2-1.1 Dynamic Firing (Appendix D, Annex 1, Paragraph D.1-1).

The dynamic firing tests are conducted from unmanned ground launch stations on an instrumented firing range to demonstrate that the munition: is safe to launch (does not eject hazardous debris or detonate upon ignition), safely separates from the launch point/tube, and travels at and explosively functions at trajectories which cause no additional hazards to the platform or firing crew.

a. The data acquired during firing should be sufficient to support weapon danger area analysis and to capture any performance data that may be related to safety.

b. Acoustic noise, blast overpressure, launch blast debris, toxic substances, thermal effects, radiation, and launcher reaction data are potential health hazards that may cause harm to the launch platform or personnel. Other system specific health hazards should be considered. See Appendix H, Annex 2.

c. Evidence is collected regarding rocket motor safety and initiation system functioning.

d. Verification of safe separation distance may be obtained from dynamic firings; if needed, additional evidence may be obtained from component level sled tests (with fuze and warhead) or from additional fuze arming distance firings in accordance with Appendix D, Annex 1, paragraph D.1-2.

e. Collect launch shock data, if required.

A.2-1.2 Fuze Safe Arming Distance Firing (Appendix D, Annex 1, Paragraph D.1-2).

These tests are used in combination with warhead arena trials to verify that the no-arm or "minimum arm distance" exceeds the safe separation distance for the item. The safe separation distance is defined as the minimum distance between personnel operating the weapon and the launched munition beyond which the hazards to the personnel resulting from the functioning of the munition are acceptable. Detailed guidance may be found in the AOP-20, Manual of Tests for the Safety Qualification of Fuzing Systems. The test munitions are launched at hot and cold temperatures on munitions that have completed sequential environmental testing in order to

identify any unacceptable fuze performance variations resulting from thermal and mechanical degradation. Tests have shown that fuze performance is highly temperature sensitive, thus, a large distribution of the distance at which the warhead functions may result. Although the quantities specified in Appendix B are considered a statistically small sample size, exposure of the munitions to the sequential environmental tests prior to firing increases the degree of confidence in the munition. Note that data from this test is also used to determine range safety parameters (i.e., Weapon Danger Area or "Safety Fan"). The specific test procedure to be conducted is dependent on the type of fuzing system.

a. The Projectile Fuze Arming Distance is used to determine the minimum arm distance for point detonating and delay type fuzing systems. The minimum arming distance is verified by arranging targets at varying distances and determining statistically the no arm distance based on the number of detonations at the various distances. Multiple test methods are described in AOP-20; the specific method selection should be based on the specific test requirements.

b. For an air burst type fuzing system, minimum arm determination by the Time to Air Burst test approach is used (AOP-20 Test D3). The fuze must be preset to function at a predetermined time or distance. An impact sensor is not involved and configuration modification is complicated by designs that typically preclude any type of pre-triggering for safety purposes. The determination of fuze function time from firing may include a variety of time measurement and fuze function/burst detection systems depending on the required accuracy and precision as described in AOP-20 Test D.3.

c. For multi-role fuze systems, sample size should be divided between the various modes and consideration should be given toward increasing the sample size if required to maintain an acceptable level of confidence. External evidence may be gathered from component level fuze tests in order to provide additional confidence in the fuze performance.

A.2-1.3 Fuze Sensitivity (Appendix D, Annex 1, Paragraph D.1-3).

Shoulder launched munitions are typically expected to penetrate light brush or other obstructions in close proximity to the launch position. Fuze sensitivity tests are normally conducted in the design phase of the munition development, but verification following an environmental test sequence is required to ensure no degradation of the system safety. Fuze sensitivity tests are conducted in accordance with Appendix D, Annex 1,paragraph D.1-3.

A.2-1.4 Fire from Enclosure (Appendix D, Annex 1, Paragraph D.1-4).

This is a special case of the free flight firing test in which munitions are fired out of specially designed rooms or enclosures. The test provides data to allow the subsequent assessment of the minimum size room from which a weapon may be fired without harming the occupants of the room. Shoulder launched munitions will require this test to be conducted on new munitions. Review weapon operational scenarios to determine its applicability. For further guidance, refer to ITOP 05-2-517.

APPENDIX A. BACKGROUND/RATIONALE.
ANNEX 2. OPERATING TESTS.

A.2-2 COMPONENT LEVEL TESTS (APPENDIX D, ANNEX 2).

A.2-2.1 Rocket Motor Tests.

Static firing and case burst tests are performed to determine the probability of catastrophic motor case rupture during firing operations. All munitions must have been subjected to extreme environmental stresses, such that the characteristic variation of the rocket motor pressure data can be obtained during the static firing and burst tests.

A.2-2.1.1 Static Firing (Appendix D, Annex 2, Paragraph D.2-1).

These tests are performed to measure maximum internal operating pressures and provide data to determine any changes of motor burn performance that may result from environmental exposure. To induce the maximum operating pressure, and to assess thermal liner/bond line integrity, the rocket motors are static fired under both high and low temperature conditions. The high temperature tests should be conducted at 63 °C or the unpackaged SRE. The cold temperature tests should be conducted at -46 °C. Although these values may be more severe than the manufacturers recommended upper and lower firing temperatures for munition performance, the extreme values should be used to assess safety aspects of the motor firing under worst case service conditions. Appropriate precautions should be taken if the firing temperature exceeds the manufacturer recommendations.

A.2-2.1.2 Burst (Appendix D, Annex 2, Paragraph D.2-2).

Burst tests are performed to measure the internal pressure required to burst the rocket motor. Characterization of the effects of the bursting motor is a secondary objective. Hydrostatic burst testing is the most commonly used test method and may be conducted with or without propellant. Evidence of motor case structural integrity should be obtained from factory fresh motor case burst testing and from environmentally stressed motor case burst testing to determine the susceptibility of the case material and seals to degradation as a result of sequential environmental testing.

A.2-2.2 Other Pressure Vessels (Appendix D, Annex 2, Paragraph D.2-3).

Appropriate burst tests should be conducted on any other pressure vessel in the munition following sequential environmental testing. This may be accomplished either through component level operational tests in the Analytical Flow or firing safety tests in the Empirical Flow.

Evidence of launch tube structural integrity should be obtained from factory fresh launch tube burst testing during design development. In addition, burst testing may be required from environmentally stressed launch tubes if a design assessment or inspections indicate susceptibility of the launch tube to structural degradation.

A.2-2.3 Warhead Arena Trials (Appendix D, Annex 2, Paragraph D.2-4).

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ANNEX 2. OPERATING TESTS.

The safe separation distance is determined by the warhead fragment characteristics (size, mass, velocity, and spatial dispersion). A sample size of at least four is required because only a portion of the total number of fragments produced is collected in the recovery medium. The sample size must be large enough to reliably evaluate fragmentation characteristics in order to determine the average fragmentation spatial dispersion. Note that data from this test is also used to determine range safety parameters (i.e., Weapon Danger Area or "Safety Fan"). This test is conducted on factory fresh assets in order to obtain the maximum fragmentation distance.

A.2-2.4 Other Energetics (Appendix D, Annex 2, Paragraph D.2-5).

Appropriate functional testing should be conducted on any other energetic in the munition following sequential environmental testing. This may be accomplished either through component level operational tests in the Analytical Flow or firing safety tests in the Empirical Flow.

A.2-2.5 Other Safety Critical Components (Appendix D, Annex 2, Paragraph D.2-6).

Although energetic and pressure vessel components account for most direct safety risks during the transportation, handling, and operation of a shoulder launched munition, other components may contribute to unsafe conditions upon launch. If it is determined that a safety critical component is susceptible to environmental degradation, operation of the component should be evaluated following sequential environmental testing either through component level operational tests in the Analytical Flow or firing safety tests in the Empirical Flow. Note that the operational tests are only required to identify potentially unsafe operation and not intended to evaluate the full performance characteristics of the components.

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ANNEX 2. OPERATING TESTS.

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APPENDIX A. BACKGROUND/RATIONALE.
ANNEX 3. NON-SEQUENTIAL SAFETY TESTS.

A.3-1 ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E3) ASSESSMENT AND TESTING (APPENDIX H, ANNEX 1).

The following electromagnetic environmental effects should be considered to assess the safety of the weapon when exposed to the environment which may be encountered during the weapon system stockpile to safe separation sequence (transportation/storage, assembly/disassembly, staged, loading/unloading, platform-loaded, and immediate post-launch). Levels should encompass sea, land, and aviation storage, usage, maintenance, and shipment requirements as identified in the LCEP.

A.3-1.1 HERO (Appendix H, Annex 1, Paragraph H.1-1).

This test provides the data required for HERO classification and assesses the safety of the weapon at a system level. HERO testing consists of exposing the weapon and its associated platform(s) to its operational electromagnetic environments and monitoring the response of the Electrically Initiated Devices (EIDs also known as Electro-explosive Devices (EEDs)) or Electronic Safe and Arming Devices (ESADs) and associated firing circuits when exposed.

A.3-1.2 ESD (Appendix H, Annex 1, Paragraph H.1-2).

These tests assess the safety of the weapon when exposed to ESD phenomenon such as those encountered during handling and helicopter transport.

A.3-1.3 Lightning Hazard (Appendix H, Annex 1, Paragraph H.1-3).

These tests assess the safety of the weapon when exposed to near and direct strike lightning, which may occur during logistic and field operations.

A.3-1.4 Electromagnetic Compatibility (Appendix H, Annex 1, Paragraph H.1-4).

Electromagnetic Compatibility (EMC) tests assess the suitability of the weapon to operate within the electromagnetic environment for which they are designed to be used. These tests are performed on a powered weapon during simulated normal operation and are designed to assess to what extent the weapon not only is affected by the electromagnetic environment in which it is expected to operate but also its electromagnetic effect on other electrical systems it interacts with or is in close proximity to (e.g., on the same platform). Much of this testing is for reliability purposes however some EMC tests provide safety assurance, for example those designed to monitor for interference carried into the weapon via physical electrical interfaces which may affect the performance of EID and/or ESAD firing circuits.

A.3-2 HEALTH HAZARDS (APPENDIX H, ANNEX 2).

Health hazard data is to be collected during the firing safety tests (see Appendix D, Annex 1). The hazards to be assessed for shoulder launched munitions are described below.

APPENDIX A. BACKGROUND/RATIONALE
ANNEX 3. NON-SEQUENTIAL SAFETY TESTS

A.3-2.1 Acoustic Energy (Impulse Noise and Blast Overpressure) (Appendix H, Annex 2, Paragraph H.2-1).

The weapon firing precipitates the sudden release of gases into the surrounding air, causing a shock wave or front to be propagated outward from the source. Firing tests are performed to measure blast overpressure and acoustic noise to determine if the shock wave damages structures and/or injures personnel. Further information may be found in MIL-STD-1474 and International Standard ISO 10843: 1997 Acoustics - Methods for the description and physical measurement of single impulses or series of impulses.

A.3-2.2 Toxic Chemical Substances (Appendix H, Annex 2, Paragraph H.2-2).

Firing of reloadable weapons in open free field areas typically do not introduce high concentrations of toxic substances to personnel/Soldiers/gunners. Medical experts will review the propellant combustion products for toxicity to determine if actual open free field measurements are required. When firing from an enclosure, a program can expect to be required to measure for toxic substances. Potential injury associated with firing from an enclosure is catastrophic (asphyxiation or secondary combustion hazards) due to high concentrations of toxic substances. Rocket exhaust gases contain toxic chemical substances such as Carbon Monoxide (CO), Carbon Dioxide (CO_2), Sulfur Dioxide (SO_2), Nitric Oxide (NO), Nitrogen Dioxide (NO_2), Hydrogen Chloride (HCl), Hydrogen Cyanide (HCN), and Lead (Pb). Other chemicals should be considered if determined to be potentially harmful to the operator. These hazards shall be evaluated with respect to the envisaged operational environment and on the basis of pertinent national laws and regulations. Data should be collected IAW TOP 02-2-614.

A.3-2.3 Radiating Energy (Appendix H, Annex 2, Paragraph H.2-3).

Weapon firings may subject the operator and/or observers to extreme heat and light exposure. The radiation of the plume generated by the propulsion unit may produce permanent or temporary eye damage (i.e., flash blindness). Exposure to heat during munition launch may cause eye and skin damage.

A.3-2.4 Launch Shock (Recoil) (Appendix H, Annex 2, Paragraph H.2-4).

Firing a recoilless weapon still produces a rearward and possibly a forward force that must be absorbed by the gunner. Excessive energy can potentially result in injury to the gunner’s shoulder. The amount of excessive energy must be determined to calculate the allowable number of rounds per 24 hour period. Typically, the impulse noise generated is the limiting factor compared to recoil energy exerted on the gunner. Testing should be conducted IAW TOP 03-2-504A. Shock levels due to weapon firing and recoil may injure the operator. The probability of injury increases with the blast energy of the weapon and the duration of the shock environment..

A.3-2.5 Launch Debris (Appendix H, Annex 2, Paragraph H.2-5).

Launch debris patterns, velocities, sizes, and masses are used to define the launch space that is unsafe for occupancy during firings.

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ANNEX 3. NON-SEQUENTIAL SAFETY TESTS.

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APPENDIX B. TEST PROGRAM FOR SHOULDER LAUNCHED MUNITIONS.

This document was developed within the international community and is written with references to both US and NATO test procedures to provide a framework for international procurement and test programs. Table I2-1 (Appendix I, Annex 2) provides cross reference of similar national and international test standards.

This Annex provides the overall S3 test programs for shoulder launched munitions. Each test program is presented in the form of test flowcharts, munition allocation tables, and test asset quantity tables. It should be noted that several non-sequential test requirements (i.e., hazard classification and insensitive munitions tests) are considered part of the overall S3 program, but are not governed by this document. For these tests, references are provided for determination of test requirements and quantities. See Chapter 8 of this document for the general description and intended application of the test flow options presented in this Annex.

APPENDIX B. TEST PROGRAM FOR SHOULDER LAUNCHED MUNITIONS.

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APPENDIX B. TEST PROGRAM FOR SHOULDER LAUNCHED MUNITIONS.
ANNEX 1. ANALYTICAL S3 TEST PROGRAM.

S3 assessment testing of shoulder launched munitions requires a series of sequential environmental tests followed by BTCA, component level operating/firing tests, and non-sequential (stand-alone) environmental tests. The overall munition quantities for the sequential and non-sequential tests are provided in Table B1-1. The Analytical S3 Test Program is illustrated in the form of test flowcharts in Figures B1-1 and B1-2 coupled with the munition allocation Table B1-2 which provides the test flow for each individual munition. Test asset quantities may be tailored in accordance with the guidelines in paragraph 6.8.

B.1-1. SAMPLE QUANTITIES FOR SEQUENTIAL ENVIRONMENTAL TESTS USING THE ANALYTICAL S3 TEST APPROACH.

A total of 36 live munitions and 10 inert rocket motors are to be subjected to sequential environmental tests. Upon completion of the environmental tests, the 10 inert rocket motor cases are burst tested and the 36 live munitions are divided into three groups and tested further as follows:

a. Six munitions are subjected to severe environment tests and then disassembled for BTCA.

b. Ten live munitions are disassembled for component level testing. The following component level tests will be required:

(1) Ten rocket motors are statically fired.

(2) Any other pressure vessel (excluding rocket motor cases) which may cause serious personnel hazards must be burst tested. A minimum of ten of each type are required to determine the safety design margin.

(3) Any other energetic devices (e.g., igniters, initiators, squibs, pyrotechnics, and thermal batteries) which may cause serious personnel hazards at the system level must be static fired. A minimum of ten of each type are required to determine the safety design margin.

c. Twenty complete rounds are dynamically fired from unmanned launch stations. This includes four rounds that are exposed to severe environment tests prior to firing. The dynamic firings are conducted at temperature extremes.

(1) Free Flight Firings are conducted on eight rounds.
(2) Fuze Arming Firings are conducted on six rounds.
(3) Fuze Sensitivity Firings are conducted on six rounds.

B.1-2. SAMPLE QUANTITIES FOR NON-SEQUENTIAL SAFETY TESTS USING THE ANALYTICAL S3 TEST APPROACH.

A minimum of 65 test assets including 5 live munitions, 3 inert munitions, 4 warheads, and 53

APPENDIX B. TEST PROGRAM FOR SHOULDER LAUNCHED MUNITIONS.
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sets of EID/ESAD's will be required for the following non-sequential safety tests:

a. Three (3) live munitions for 12-metre Logistic Drop.

b. One (1) live munition for Shipboard UNDEX Safety Shock.

c. One (1) live and three (3) inert munitions for use with 51 ea EID/ESADs required for Electromagnetic Environmental Effects (E3) assessment tests. Instrumented components may be substituted where actual measurement of the maximum no-fire stimulus may be obtained. Systems or subsystems incorporating ESAD's must be tested while in the functional mode. At a minimum, E3 assessment tests will include the following:

(1) One (1) live munition and one (1) inert munition with 20 live sets of EID/ESAD's for Lightning Hazard.

(2) One (1) inert munition with one instrumented EID/ESAD for HERO tests.

(3) One (1) inert munition with 32 live sets of EID/ESAD's for ESD tests.

d. Additional inert munitions may be required for Operational and Maintenance Review as described in Appendix H, Annex 3.

e. Additional live munitions will be required for Hazard Classification Testing per TB 700-2.

f. Additional munitions will be required for Insensitive Munitions Tests per MIL-STD-2105, STANAG 4439 and AOP-39.

g. Four modified munitions will be required for Warhead Arena Trials.

h. Systems or subsystems incorporating firing circuits controlled by electronics must be tested while in the functional mode if the threat is present when they are powered.

i. Additional test assets may be required for fuze S3 testing per MIL-STD-331.

j. Additional test assets may be required for other safety tests determined to be necessary to address special circumstances not considered in this document or as the result of marginal or inconclusive test results throughout the overall S3 test program.

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ANNEX 1. ANALYTICAL S3 TEST PROGRAM.

TABLE B1-1. ENVIRONMENTAL TEST ASSET QUANTITIES FOR ANALYTICAL S3 PROGRAM

TESTS	LIVE MUNITIONS[1]	INERT MUNITIONS[2]	OTHER UNITS OR COMPONENTS
SEQUENTIAL ENVIRONMENTAL TESTS:			
Component Test Sequence[4]	10	---	---
BTCA Test Sequence	6	---	---
Dynamic Firing Test Sequence	20	---	---
Rocket Motor Case Burst Test Sequence	---	10	---
NON-SEQUENTIAL ENVIRONMENTAL TESTS:			
12m Logistic Drop	3	---	---
Shipboard UNDEX Safety Shock	1	---	---
HERO	--	1	1 of each EID/ESAD[5]
ESD	---	1	32 of each EID/ESAD
Lightning Hazard	16	1	20 of each EID/ESAD
Warhead Arena	4	---	---
Totals	45	13	53

NOTE 1: Live munitions contain all safety critical components. They may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives.

NOTE 2: Inert Munitions contain no energetic materials and may contain mass simulants to replace components that are unrelated to the test objectives.

NOTE 4: These units are derived from disassembled component test sequence assets. If the munition cannot be disassembled, then additional environmentally tested units may be required to provide this data.

NOTE 5: Back-up EIDs may be required for the HERO test otherwise a damaged unit resulting from the modification/instrumentation/testing processes may delay the assessment program.

NOTE 6: The requirement for 1 live munition for the direct strike lightning test may be tailored based on Nation specific requirements.

APPENDIX B. TEST PROGRAM FOR SHOULDER LAUNCHED MUNITIONS.
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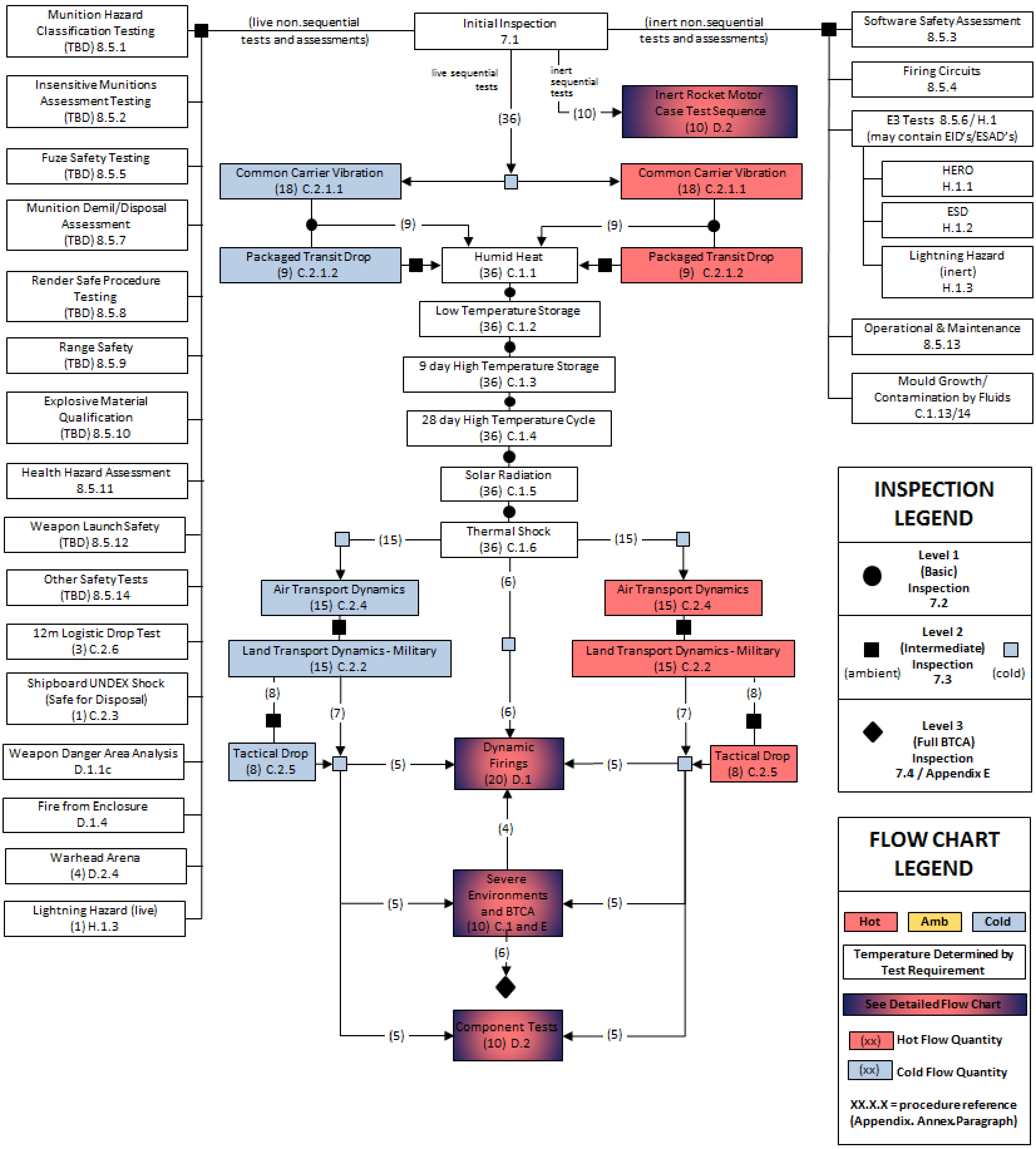

Figure B1-1. Test Flowchart for Analytical S3 Test Program.

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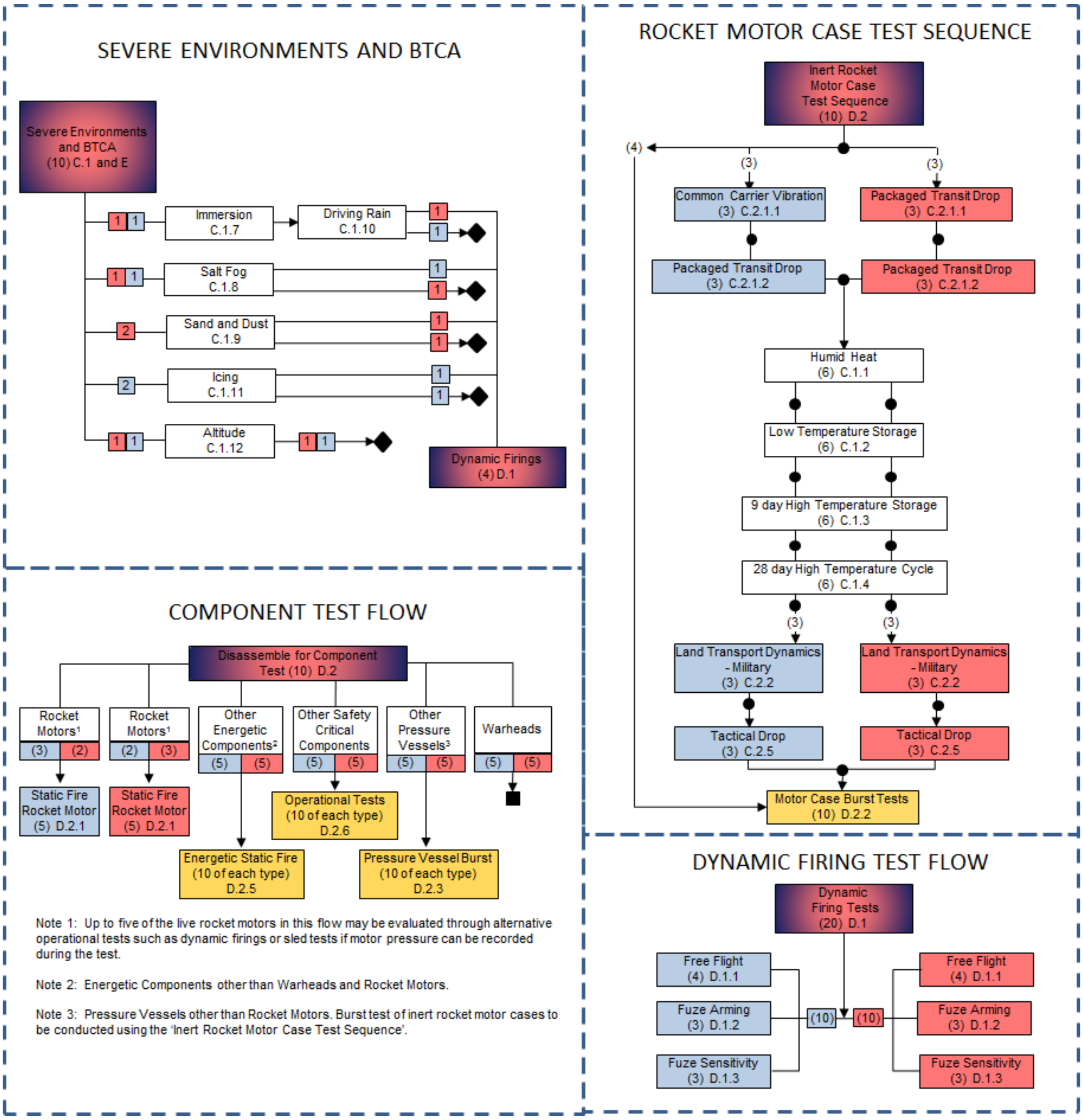

Figure B1-2. Test Flowchart for Analytical S3 Test Program.

APPENDIX B. TEST PROGRAM FOR SHOULDER LAUNCHED MUNITIONS
ANNEX 1. ANALYTICAL S3 TEST PROGRAM

TABLE B1-2. SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 ANALYTICAL TEST PROGRAM – HOT SEQUENCE.

		Munition number (Live Munitions - Hot Sequential Environmental Test Flow)																	
Test serial	App/Annex/Para	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Common carrier vibration	C.2.1.1	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h
Packaged transit drop	C.2.1.2	h	h			h	h			h	h		h	h			h		
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Humid heat	C.1.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Low temperature storage	C.1.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
High temperature storage	C.1.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
High temperature cycling	C.1.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Solar radiation	C.1.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Thermal shock	C.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Air Transport Dynamics - Military	C.2.4	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h			
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Land Transport Dynamics - Military	C.2.2	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h			
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Tactical Drop	C.2.5	h		h		h		h		h		h	h		h				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Immersion	C.1.7	x																	
Salt Fog	C.1.8		x																
Sand and Dust	C.1.9			x	x														
Driving Rain	C.1.10	x																	
Icing	C.1.11																		
Altitude	C.1.12					x													
Level 3 Inspection (Reduced BTCA)	7.4		a		a	a													
Dynamic Firing Tests - Free Flight	D.1.1	h		h														h	c
Dynamic Firing Tests - Fuze Arming	D.1.2												h	h	c				
Dynamic Firing Tests - Fuze Sensitivity	D.1.3											h				c	h		
Rocket motor static firing	D.2.1						h	c	h	c	h								
Rocket motor burst	D.2.2																		
Other pressure vessel burst integrity	D.2.3						a	a	a	a	a								
Warhead Level 2 Inspection (component level)	7.3						a	a	a	a	a								
Other energetic static fire	D.2.5						a	a	a	a	a								
Other safety critical components operational	D.2.6						a	a	a	a	a								

Key:
a = ambient test   h = hot conditioned test
c = cold conditioned test   x = required (test temperature defined in test)

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ANNEX 1. ANALYTICAL S3 TEST PROGRAM.

TABLE B1-3. SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 ANALYTICAL TEST PROGRAM – COLD SEQUENCE

		Munition number (Live Munitions - Cold Sequential Environmental Test Flow)																	
Test serial	App/Annex/Para	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Common carrier vibration	C.2.1.1	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Packaged transit drop	C.2.1.2	c	c			c	c			c	c		c	c			c		
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Humid heat	C.1.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Low temperature storage	C.1.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
High temperature storage	C.1.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
High temperature cycling	C.1.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Solar radiation	C.1.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Thermal shock	C.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Air Transport Dynamics - Military	C.2.4	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c			
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Land Transport Dynamics - Military	C.2.2	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Tactical Drop	C.2.5	c		c		c		c		c		c	c		c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Immersion	C.1.7	x																	
Salt Fog	C.1.8		x																
Sand and Dust	C.1.9																		
Driving Rain	C.1.10	x																	
Icing	C.1.11			x	x														
Altitude	C.1.12					x													
Level 3 Inspection (Reduced BTCA)	7.4	a			a	a													
Dynamic Firing Tests - Free Flight	D.1.1		c	c														h	c
Dynamic Firing Tests - Fuze Arming	D.1.2												c	h	c				
Dynamic Firing Tests - Fuze Sensitivity	D.1.3											c				c	h		
Rocket motor static firing	D.2.1						c	h	c	h	c								
Rocket motor burst	D.2.2																		
Other pressure vessel burst integrity	D.2.3						a	a	a	a	a								
Warhead Level 2 Inspection (component level)	7.3						a	a	a	a	a								
Other energetic static fire	D.2.5						a	a	a	a	a								
Other safety critical components operational	D.2.6						a	a	a	a	a								

Key:
a = ambient test h = hot conditioned test
c = cold conditioned test x = required (test temperature defined in test)

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TABLE B1-4. SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 ANALYTICAL TEST PROGRAM – INERT MOTOR CASE SEQUENCE

		Motor Case Sequence (Inert)									
Test serial	App/Annex/Para	1	2	3	4	5	6	7	8	9	10
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a
Common carrier vibration	C.2.1.1										
Packaged transit drop	C.2.1.2	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Humid heat	C.1.1	x	x	x	x	x	x				
Low temperature storage	C.1.2	x	x	x	x	x	x				
High temperature storage	C.1.3	x	x	x	x	x	x				
High temperature cycling	C.1.4	x	x	x	x	x	x				
Solar radiation	C.1.5										
Thermal shock	C.1.6										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Air Transport Dynamics - Military	C.2.4										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3										
Land Transport Dynamics - Military	C.2.2	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Tactical Drop	C.2.5	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Immersion	C.1.7										
Salt Fog	C.1.8										
Sand and Dust	C.1.9										
Driving Rain	C.1.10										
Icing	C.1.11										
Altitude	C.1.12										
Level 3 Inspection (Reduced BTCA)	7.4										
Dynamic Firing Tests - Free Flight	D.1.1										
Dynamic Firing Tests - Fuze Arming	D.1.2										
Dynamic Firing Tests - Fuze Sensitivity	D.1.3										
Rocket motor static firing	D.2.1										
Rocket motor burst	D.2.2	a	a	a	a	a	a	a	a	a	a
Other pressure vessel burst integrity	D.2.3										
Warhead Level 2 Inspection (component level)	7.3										
Other energetic static fire	D.2.5										
Other safety critical components operational	D.2.6										

Key:
a = ambient test   h = hot conditioned test
c = cold conditioned test   x = required (test temperature defined in test)

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S3 assessment testing of shoulder launched munitions requires a series of sequential environmental tests followed by BTCA, operating/firing tests, and non-sequential (stand-alone) environmental tests. The overall munition quantities for the sequential and non-sequential tests are provided in Table B2-1. The Empirical S3 Test Program is illustrated in the form of test flowcharts in Figures B2-1 and B2-2 coupled with the munition allocation Table B2-2 which provides the sequential environmental test flow for each individual munition. Test asset quantities may be tailored in accordance with the guidelines in paragraph 6.8.

B.2-1. SAMPLE QUANTITIES FOR SEQUENTIAL ENVIRONMENTAL TESTS USING THE EMPIRICAL S3 TEST APPROACH.

A total of 120 live munitions and 10 inert motor cases are to be subjected to sequential environmental tests. The live munitions may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives. Upon completion of the environmental tests, the ten inert motor cases are burst tested and the 120 live munitions are divided into three groups and tested further as follows:

a. Eight live munitions are subjected to severe environment tests and the reduced BTCA requirements selected from Appendix E.

b. 102 complete rounds are dynamically fired from unmanned launch stations. This includes 32 rounds that are exposed to severe environment tests prior to firing.

(1) Free Flight Firings are conducted on 54 rounds.
(2) Fuze Arming Firings are conducted on 40 rounds.
(3) Fuze Sensitivity Firings are conducted on 8 rounds.

c. Ten live rocket motors are fired from a ground launch station.

B.2-2. SAMPLE QUANTITIES FOR NON-SEQUENTIAL TESTS USING THE EMPIRICAL S3 TEST APPROACH.

A minimum of 64 test assets including 4 live munitions, 3 inert munitions, 4 warheads, and 53 sets of EID/ESAD’s will be required for the following non-sequential safety tests. Five live munitions will be required in each firing orientation for baseline dynamic firings:

a. Three (3) live munitions for 12-metre Logistic Drop.

b. One (1) live and three (3) inert munitions for use with 53 ea EID/ESADs required for Electromagnetic Environmental Effects (E3) assessment tests. Instrumented components may be substituted where actual measurement of the maximum no-fire stimulus may be obtained. Systems or subsystems incorporating ESAD's must be tested while in the functional mode. At a minimum, E3 assessment tests will include the following:

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(1) One (1) live munition and 1 inert munition with 20 live sets of EID/ESAD's for Lightning Hazard.

(2) One (1) inert munition with one instrumented EID/ESAD for HERO tests.

(3) One (1) inert munition with 32 live sets of EID/ESAD's for ESD tests.

c. Additional inert munitions may be required for Operational and Maintenance Review as described in Appendix H, Annex 3.

d. Additional live munitions will be required for Hazard Classification Testing per TB 700-2.

e. Additional munitions will be required for Insensitive Munitions Tests per MIL-STD-2105, STANAG 4439 and AOP-39..

f. Four modified munitions will be required for Warhead Arena Trials.

g. Systems or subsystems incorporating firing circuits controlled by electronics must be tested while in the functional mode if the threat is present when they are powered.

h. Additional test assets may be required for fuze S3 testing per MIL-STD-331.

i. Five live munitions will be required for each of the primary firing orientations for baseline dynamic firings as described in Appendix D, Annex 1. The number of firing orientations and temperature of the baseline firings will be determined based on the system design and performance requirements.

i. Additional test assets may be required for other safety tests determined to be necessary to address special circumstances not considered in this document or as the result of marginal or inconclusive test results throughout the overall S3 test program.

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TABLE B2-1. ENVIRONMENTAL TEST ASSET QUANTITIES FOR EMPIRICAL S3 PROGRAM

TESTS	LIVE MUNITIONS[1]	INERT MUNITIONS[2]	OTHER UNITS OR COMPONENTS
Sequential Environmental Tests:			
Reduced BTCA Test Sequence	11[(6)]	---	---
Dynamic Firing Test Sequence	99[(3)]	---	---
Static Rocket Motor Firing Sequence	10	---	---
Rocket Motor Case Burst Test Sequence	---	10	---
Non-Sequential Environmental Tests:			
Baseline Dynamic Firings	5 per orientation	---	---
12m Logistic Drop	3	---	---
Shipboard UNDEX Safety Shock	1	---	1 each EID/ESAD(4)
HERO	---	1	32 each EID/ESAD
ESD	---	1	20 each EID/ESAD
Lightning Hazard	1[(5)]	1	---
Warhead Arena	4	---	---
Totals	129 + 5 per firing orientation	13	53

NOTE 1: Live munitions contain all safety critical components. They may contain mass simulants to replace components that are unrelated to the munition safety (e.g., guidance, control). Configurations may vary according to particular test objectives.

NOTE 2: Inert Munitions contain no energetic materials and may contain mass simulants to replace components that are unrelated to the test objectives.

NOTE 3: Fully functional munitions suitable for firing safety tests.

NOTE 4: Back-up EIDs may be required for the HERO test otherwise a damaged unit resulting from the modification/instrumentation/testing processes may delay the assessment program.

NOTE 5: The requirement for 1 live munition for the direct strike lightning test may be tailored based on Nation specific requirements.

NOTE 6: If the Reduced BTCA assets are suitable, they may be used for static firings. This would reduce overall test quantities accordingly. Full BTCA assets will not be suitable for static firings.

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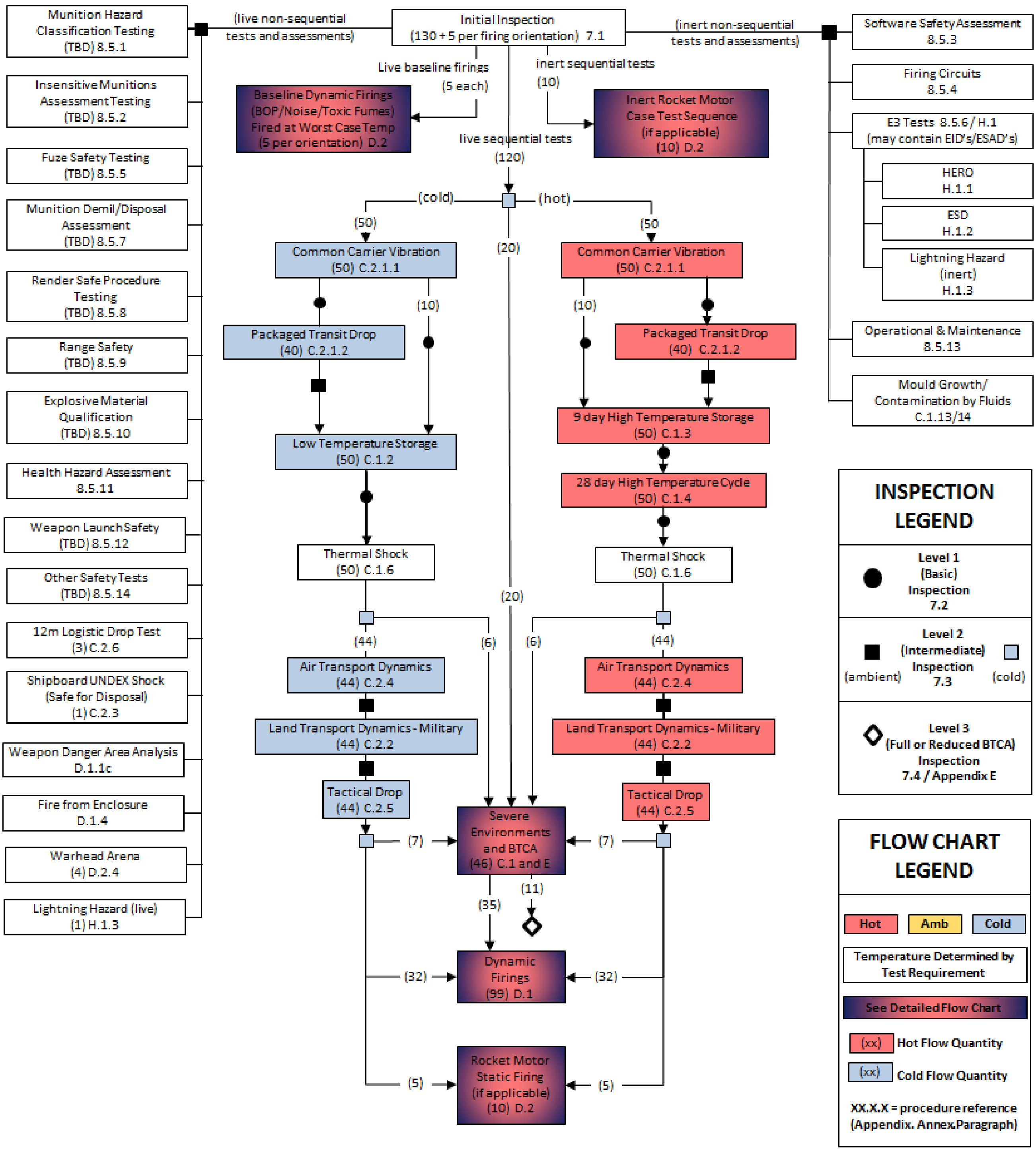

Figure B2-1. Test Flowchart for Empirical S3 Test Program.

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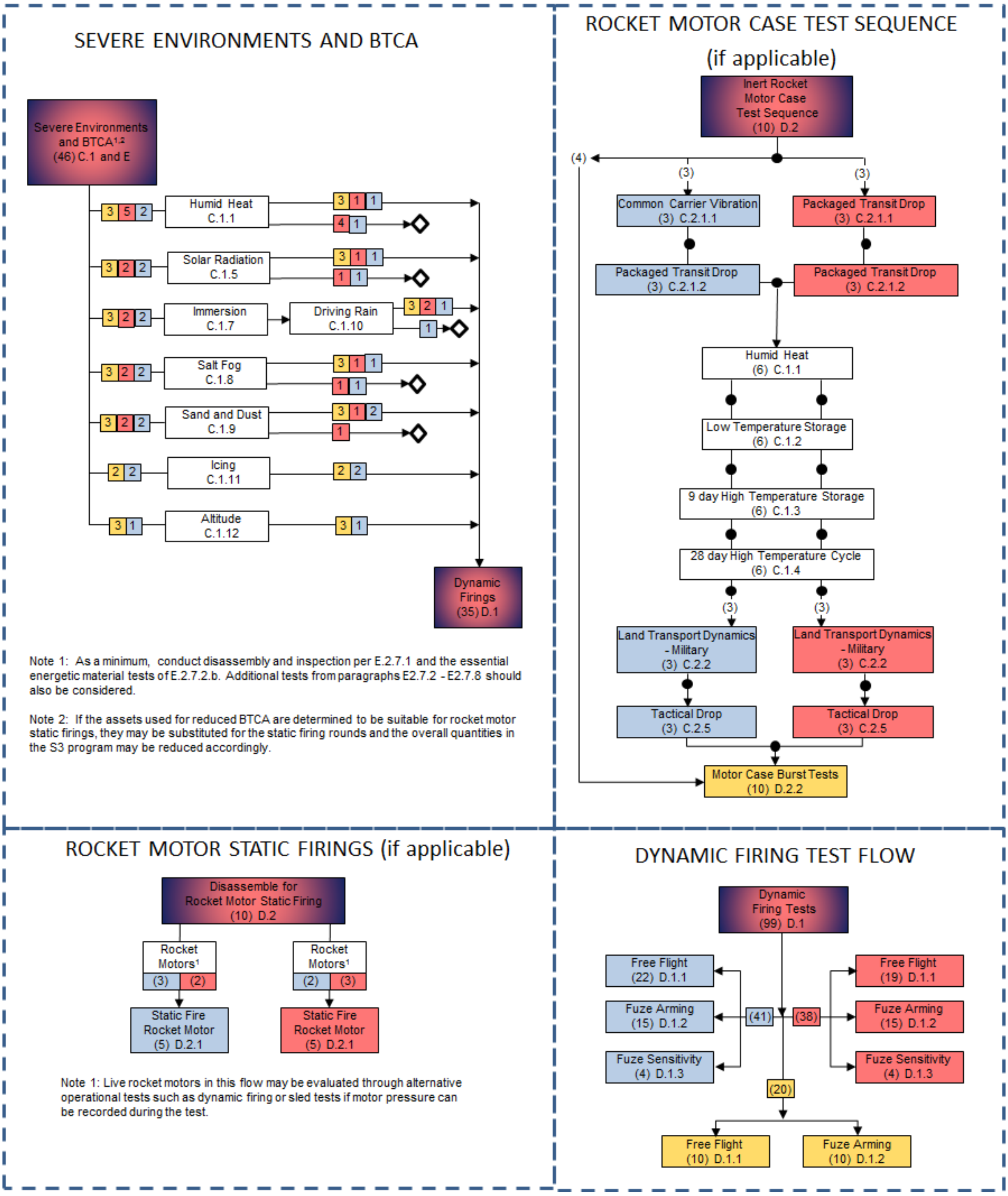

Figure B2-2. Test Flowcharts for Empirical S3 Test Program.

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TABLE B2-2. SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 EMPIRICAL TEST PROGRAM – HOT SEQUENCE

		Munition number (Live Munitions - Hot Sequential Environmental Test Flow)																						
Test serial	App/Annex/Para	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22-39	40-50
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Common carrier vibration	C.2.1.1	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h
Packaged transit drop	C.2.1.2	h		h		h	h	h				h		h		h		h			h	h	h	h
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Low temperature storage	C.1.2																							
High temperature storage	C.1.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
High temperature cycling	C.1.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Thermal shock	C.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Air Transport Dynamics - Military	C.2.4	h	h	h		h			h	h	h	h		h	h	h	h	h		h		h	h	h
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a		a			a	a	a	a		a	a	a	a	a		a		a	a	a
Land Transport Dynamics - Military	C.2.2	h	h	h		h			h	h	h	h		h	h	h	h	h		h		h	h	h
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a		a			a	a	a	a		a	a	a	a	a		a		a	a	a
Tactical Drop	C.2.5	h	h	h		h			h	h	h	h		h	h	h	h	h		h		h	h	h
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c		c			c	c	c	c		c	c	c	c	c		c		c	c	c
Humid heat	C.1.1	x				x	x	x						x										
Solar radiation	C.1.5		x						x															
Immersion	C.1.7									x		x												
Salt Fog	C.1.8			x									x											
Sand and Dust	C.1.9				x						x													
Driving Rain	C.1.10									x		x												
Icing	C.1.11																							
Altitude	C.1.12																							
Level 3 Inspection (Reduced BTCA)	7.4	a	a	a	a	a	a	a																
Dynamic Firing Tests - Free Flight	D.1.1											c	c										h	
Dynamic Firing Tests - Fuze Arming	D.1.2								h					c	c									h
Dynamic Firing Tests - Fuze Sensitivity	D.1.3									h	h					c	c							
Rocket motor static firing	D.2.1																	h	h	h	c	c		
Rocket motor burst	D.2.2																							

Key:
a = ambient test h = hot conditioned test
c = cold conditioned test x = required (test temperature defined in test)

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TABLE B2-3. SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 EMPIRICAL TEST PROGRAM – COLD SEQUENCE

		Munition number (Live Munitions - Cold Sequential Environmental Test Flow)																						
Test serial	App/Annex/Para	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72-89	90-100
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Common carrier vibration	C.2.1.1	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Packaged transit drop	C.2.1.2	c		c		c	c	c				c		c		c		c			c	c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Low temperature storage	C.1.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
High temperature storage	C.1.3																							
High temperature cycling	C.1.4																							
Thermal shock	C.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Air Transport Dynamics - Military	C.2.4	c	c	c		c		c	c	c	c	c			c	c	c	c		c		c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a		a		a	a	a	a	a			a	a	a	a		a		a	a	a
Land Transport Dynamics - Military	C.2.2	c	c	c		c		c	c	c	c	c			c	c	c	c		c		c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a		a		a	a	a	a	a			a	a	a	a		a		a	a	a
Tactical Drop	C.2.5	c	c	c		c		c	c	c	c	c			c	c	c	c		c		c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c		c		c	c	c	c	c			c	c	c	c		c		c	c	c
Humid heat	C.1.1	x				x																		
Solar radiation	C.1.5		x									x												
Immersion	C.1.7			x							x													
Salt Fog	C.1.8				x								x											
Sand and Dust	C.1.9									x				x										
Driving Rain	C.1.10			x							x													
Icing	C.1.11						x	x																
Altitude	C.1.12								x															
Level 3 Inspection (Reduced BTCA)	7.4	a	a	a	a																			
Dynamic Firing Tests - Free Flight	D.1.1					c	c					h											c	
Dynamic Firing Tests - Fuze Arming	D.1.2							c	c				h	h	h									c
Dynamic Firing Tests - Fuze Sensitivity	D.1.3									c	c					h	h							
Rocket motor static firing	D.2.1																	c	c	c	h	h		
Rocket motor burst	D.2.2																							

Key:
a = ambient test h = hot conditioned test
c = cold conditioned test x = required (test temperature defined in test)

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TABLE B2-4. SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 EMPIRICAL TEST PROGRAM – SEVERE ENVIRONMENT SEQUENCE

		Munition number (Live Munitions - Severe Environment Test Flow)																			
Test serial	App/Annex/Para	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Common carrier vibration	C.2.1.1																				
Packaged transit drop	C.2.1.2																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3																				
Low temperature storage	C.1.2																				
High temperature storage	C.1.3																				
High temperature cycling	C.1.4																				
Thermal shock	C.1.6																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3																				
Air Transport Dynamics - Military	C.2.4																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3																				
Land Transport Dynamics - Military	C.2.2																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3																				
Tactical Drop	C.2.5																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3																				
Humid heat	C.1.1	x	x	x																	
Solar radiation	C.1.5				x	x	x														
Immersion	C.1.7							x	x	x											
Salt Fog	C.1.8										x	x	x								
Sand and Dust	C.1.9													x	x	x					
Driving Rain	C.1.10							x	x	x											
Icing	C.1.11																x	x			
Altitude	C.1.12																		x	x	x
Level 3 Inspection (Reduced BTCA)	7.4																				
Dynamic Firing Tests - Free Flight	D.1.1	a		a		a		a		a		a		a		a		a		a	
Dynamic Firing Tests - Fuze Arming	D.1.2		a		a		a		a		a		a		a		a		a		a
Dynamic Firing Tests - Fuze Sensitivity	D.1.3																				
Rocket motor static firing	D.2.1																				
Rocket motor burst	D.2.2																				

Key:
a = ambient test h = hot conditioned test
c = cold conditioned test x = required (test temperature defined in test)

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TABLE B2-5. SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 EMPIRICAL TEST PROGRAM – INERT ROCKET MOTOR SEQUENCE

		Motor Case Sequence (Inert)									
Test serial	App/Annex/Para	1	2	3	4	5	6	7	8	9	10
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a
Common carrier vibration	C.2.1.1										
Packaged transit drop	C.2.1.2	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Low temperature storage	C.1.2	x	x	x	x	x	x				
High temperature storage	C.1.3	x	x	x	x	x	x				
High temperature cycling	C.1.4	x	x	x	x	x	x				
Thermal shock	C.1.6										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Air Transport Dynamics - Military	C.2.4										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3										
Land Transport Dynamics - Military	C.2.2	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Tactical Drop	C.2.5	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Humid heat	C.1.1	x	x	x	x	x	x				
Solar radiation	C.1.5										
Immersion	C.1.7										
Salt Fog	C.1.8										
Sand and Dust	C.1.9										
Driving Rain	C.1.10										
Icing	C.1.11										
Altitude	C.1.12										
Mud	C.1.13										
Level 3 Inspection (Reduced BTCA)	7.4										
Dynamic Firing Tests - Free Flight	D.1.1										
Dynamic Firing Tests - Fuze Arming	D.1.2										
Dynamic Firing Tests - Fuze Sensitivity	D.1.3										
Rocket motor static firing	D.2.1										
Rocket motor burst	D.2.2	a	a	a	a	a	a	a	a	a	a

Key:
a = ambient test h = hot conditioned test
c = cold conditioned test x = required (test temperature defined in test)

APPENDIX B. TEST PROGRAM FOR SHOULDER LAUNCHED MUNITIONS.
ANNEX 3. WORKED EXAMPLE OF TEST TAILORING FOR A SHOULDER LAUNCHED MISSILE.

B.3-1. INTRODUCTION.

The text below gives a worked example showing how the test quantities from an Empirical S3 Test Program can be tailored given a specific set of circumstances. It is not to be used as the definitive test quantities set or as a substitute for those quantities provided in Appendix B, Annex 2. A similar approach can be used for the Analytical S3 Test Program. As stated in paragraph 6.3, deviations from the S3 assessment testing program shall be approved by National S3 Authority(ies) or other appropriate Authorities prior to the start of testing.

B.3-2. TEST QUANTITIES TAILORING – WORKED EXAMPLE.

B.3-2.1 Example System Description.

For the purposes of this example, an S3 test program is to be conducted for a previously fielded system with a new propulsion unit. The modifications include new propellant charge weight and new igniter, but structural and sealing components remain unchanged. Substantial igniter development data has been provided. Warhead, guidance, and seeker systems are unchanged, as is the anticipated user environment. The warhead safe and arming/fuze component(s) have been qualified (or has a favourable S3 assessment) in accordance with MIL-STD-331 or AOP-20.

B.3-2.2 Tailoring of Test Asset Configuration.

Non-tactical components: The test assets may include inert warhead and other non-tactical components if those components have previously completed S3 testing with the exception that fully functional guidance and control systems will be required for the firing safety test assets. Any non-tactical mass simulants are required to have thermal, structural, and dynamic characteristics similar to the tactical hardware.

B.3-2.3 Sequential Environmental Trial and Operation Test Tailoring Considerations.

B.3-2.3.1 Reduction in Climatic Test Requirements.

Immersion, Salt Fog, Sand and Dust, Rain/Watertightness, Icing, and Altitude tests may be eliminated since no changes to the weapon seals have been made.

B.3-2.3.2 Reduction in BTCA Test Requirements.

BTCA is an underpinning principle of S3 testing and analysis since this provides significant information in respect to residual safety margins. Furthermore, BTCA data obtained as part of a S3 program can also form the body of evidence to be used during subsequent In-Service Surveillance activities. Additionally, some Nations place greater emphasis on the results of BTCA than other tests. For these reasons this cannot be eliminated from any S3 program. Four assets is the minimum for this example in order to provide adequate material for the required

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AOP-7 testing. Furthermore, BTCA is only required for the new components (rocket motor and igniter).

B.3-2.3.3 Reduction in Firing Safety Test Requirements.

Firing safety tests should not be eliminated, but the quantities may be reduced based on confidence from prior field experience, developmental tests, and static firing data. Minimum quantities for this example are five hot and five cold for Dynamic Firing. The Fuze system firings may be eliminated since the fuze is unchanged.

B.3-2.3.4 Elimination of Rocket Motor Case Test Requirements.

These tests may be eliminated since no material change to the pressure vessel or structural components of the propulsion unit and prior S3 showed no material degradation and substantial safety margin. Burst integrity will be further assessed based on Static Firing data.

B.3-2.3.5 Use Of Development Test Data.

Substantial development data has been provided and reviewed; and the assessment of the design has been found to support the reduction of test quantities.

B.3-2.4 Non-Sequential Test Tailoring Considerations.

B.3-2.4.1 Reduction in 12-Metre Logistic Safety Drop Test Asset Quantity.

Since the full system has been previously qualified, only one missile with live propulsion unit (non-tactical warhead, guidance and seeker) is required. This drop needs to be in the worst case orientation for the propulsion unit.

B.3-2.4.2 Elimination of Fluid Contamination and Mold Growth Test Requirements.

These tests may be eliminated since no changes to the structural components or weapon seals have been made.

B.3-3. TAILORED TEST PROGRAM.

Based on the preceding discussion, the following test assets may be reduced from the Empirical S3 Test Flow:

a. 10 ea Rocket Motor Burst Integrity

b. 52 ea Dynamic Firing Tests

This effectively eliminates the rocket motor bursts testing and removes 52 munitions from the 120 munition sequential test program as shown in Tables B3-1 through B3-4 leaving just 68

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weapons as shown in Table B3-5. Additionally, the number of weapons required for Logistic Drop Testing is reduced from three to one and further reductions may be achieved for Insensitive Muntions, Hazard Classification, and E3 tests. Five live munitions will still be required in each firing orientation for baseline firings.

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ANNEX 3. WORKED EXAMPLE OF TEST TAILORING FOR A SHOULDER LAUNCHED MISSILE SYSTEM.

TABLE B3-1. EXAMPLE TAILORED SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 EMPIRICAL TEST PROGRAM – HOT FLOW

		Munition number (Live Munitions - Hot Sequential Environmental Test Flow)																						
Test serial	App/Annex/Para	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22-39	40-50
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Common carrier vibration	C.2.1.1	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h
Packaged transit drop	C.2.1.2	h		h		h	h	h				h		h		h		h			h	h	h	h
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Low temperature storage	C.1.2																							
High temperature storage	C.1.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
High temperature cycling	C.1.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Thermal shock	C.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Air Transport Dynamics - Military	C.2.4	h	h	h		h			h	h	h	h		h	h	h	h	h		h		h	h	h
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a		a			a	a	a	a		a	a	a	a	a		a		a	a	a
Land Transport Dynamics - Military	C.2.2	h	h	h		h			h	h	h	h		h	h	h	h	h		h		h	h	h
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a		a			a	a	a	a		a	a	a	a	a		a		a	a	a
Tactical Drop	C.2.5	h	h	h		h			h	h	h	h		h	h	h	h	h		h		h	h	h
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c		c			c	c	c	c		c	c	c	c	c		c		c	c	c
Humid heat	C.1.1	x				x	x	x																
Solar radiation	C.1.5		x						x															
Immersion	C.1.7									x		x												
Salt Fog	C.1.8			x									x											
Sand and Dust	C.1.9				x						x													
Driving Rain	C.1.10									x		x												
Icing	C.1.11																							
Altitude	C.1.12																							
Level 3 Inspection (Reduced BTCA)	7.4	a	a	a	a	a	a	a																
Dynamic Firing Tests - Free Flight	D.1.1											c	c										h	
Dynamic Firing Tests - Fuze Arming	D.1.2								h					c	c									h
Dynamic Firing Tests - Fuze Sensitivity	D.1.3									h	h					c	c							
Rocket motor static firing	D.2.1																	h	h	h	c	c		
Rocket motor burst	D.2.2																							

Key:
a = ambient test h = hot conditioned test
c = cold conditioned test x = required (test temperature defined in test)

Eliminated as a test requirement.

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TABLE B3-2. EXAMPLE TAILORED SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 EMPIRICAL TEST PROGRAM – COLD FLOW

		Munition number (Live Munitions - Cold Sequential Environmental Test Flow)																						
Test serial	App/Annex/Para	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72-89	90-100
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Common carrier vibration	C.2.1.1	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Packaged transit drop	C.2.1.2	c		c		c	c	c				c		c		c		c			c	c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Low temperature storage	C.1.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
High temperature storage	C.1.3																							
High temperature cycling	C.1.4																							
Thermal shock	C.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Air Transport Dynamics - Military	C.2.4	c	c	c		c		c	c	c	c	c			c	c	c	c		c		c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a		a		a	a	a	a	a			a	a	a	a		a		a	a	a
Land Transport Dynamics - Military	C.2.2	c	c	c		c		c	c	c	c	c			c	c	c	c		c		c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a		a		a	a	a	a	a			a	a	a	a		a		a	a	a
Tactical Drop	C.2.5	c	c	c		c		c	c	c	c	c			c	c	c	c		c		c	c	c
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c		c		c	c	c	c	c			c	c	c	c		c		c	c	c
Humid heat	C.1.1	x				x																		
Solar radiation	C.1.5		x									x												
Immersion	C.1.7			x							x													
Salt Fog	C.1.8				x								x											
Sand and Dust	C.1.9									x				x										
Driving Rain	C.1.10			x							x													
Icing	C.1.11						x	x																
Altitude	C.1.12								x															
Level 3 Inspection (Reduced BTCA)	7.4	a	a	a	a																			
Dynamic Firing Tests - Free Flight	D.1.1					c	c					h											c	
Dynamic Firing Tests - Fuze Arming	D.1.2							c	c				h	h	h									c
Dynamic Firing Tests - Fuze Sensitivity	D.1.3									c	c					h	h							
Rocket motor static firing	D.2.1																	c	c	c	h	h		
Rocket motor burst	D.2.2																							

Key:
a = ambient test h = hot conditioned test
c = cold conditioned test x = required (test temperature defined in test)

(shaded) Eliminated as a test requirement.

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TABLE B3-3. EXAMPLE TAILORED SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 EMPIRICAL TEST PROGRAM SEVERE ENVIRONMENTS FLOW

		Munition number (Live Munitions - Severe Environment Test Flow)																			
Test serial	App/Annex/Para	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Common carrier vibration	C.2.1.1																				
Packaged transit drop	C.2.1.2																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3																				
Low temperature storage	C.1.2																				
High temperature storage	C.1.3																				
High temperature cycling	C.1.4																				
Thermal shock	C.1.6																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3																				
Air Transport Dynamics - Military	C.2.4																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3																				
Land Transport Dynamics - Military	C.2.2																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3																				
Tactical Drop	C.2.5																				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3																				
Humid heat	C.1.1	x	x	x																	
Solar radiation	C.1.5				x	x	x														
Immersion	C.1.7							x	x	x											
Salt Fog	C.1.8										x	x	x								
Sand and Dust	C.1.9													x	x	x					
Driving Rain	C.1.10							x	x	x											
Icing	C.1.11																x	x			
Altitude	C.1.12																		x	x	x
Level 3 Inspection (Reduced BTCA)	7.4																				
Dynamic Firing Tests - Free Flight	D.1.1	a	a	a	a	a	a	a		a		a		a		a		a		a	
Dynamic Firing Tests - Fuze Arming	D.1.2		a		a		a		a		a		a		a		a		a		a
Dynamic Firing Tests - Fuze Sensitivity	D.1.3																				
Rocket motor static firing	D.2.1																				
Rocket motor burst	D.2.2																				

Key:
a = ambient test h = hot conditioned test
c = cold conditioned test x = required (test temperature defined in test)

Eliminated as a test requirement.

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TABLE B3-4. EXAMPLE TAILORED SEQUENTIAL TEST ROUND ALLOCATION TABLE FOR THE S3 EMPIRICAL TEST PROGRAM – INERT MOTOR CASE SEQUENCE

		Motor Case Sequence (Inert)									
Test serial	App/Annex/Para	1	2	3	4	5	6	7	8	9	10
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a
Common carrier vibration	C.2.1.1										
Packaged transit drop	C.2.1.2	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Low temperature storage	C.1.2	x	x	x	x	x	x				
High temperature storage	C.1.3	x	x	x	x	x	x				
High temperature cycling	C.1.4	x	x	x	x	x	x				
Thermal shock	C.1.6										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Air Transport Dynamics - Military	C.2.4										
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3										
Land Transport Dynamics - Military	C.2.2	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Tactical Drop	C.2.5	h	h	h	c	c	c				
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a				
Humid heat	C.1.1	x	x	x	x	x	x				
Solar radiation	C.1.5										
Immersion	C.1.7										
Salt Fog	C.1.8										
Sand and Dust	C.1.9										
Driving Rain	C.1.10										
Icing	C.1.11										
Altitude	C.1.12										
Level 3 Inspection (Reduced BTCA)	7.4										
Dynamic Firing Tests - Free Flight	D.1.1										
Dynamic Firing Tests - Fuze Arming	D.1.2										
Dynamic Firing Tests - Fuze Sensitivity	D.1.3										
Rocket motor static firing	D.2.1										
Rocket motor burst	D.2.2	a	a	a	a	a	a	a	a	a	a

Key:
a = ambient test h = hot conditioned test
c = cold conditioned test x = required (test temperature defined in test)

Eliminated as a test requirement.

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TABLE B3-5. EXAMPLE TAILORED SEQUENTIAL ROUND ALLOCATION FOR EMPIRICAL S3 TEST PROGRAM - CONDENSED

		Munition number (Live Munitions - Hot Sequential Environmental Test Flow)															Munition number (Live Munitions - Cold Sequential Environmental Test Flow)													Munition number (Live Munitions Severe Environment Test Flow)					
Test serial	App/Annex/Para	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15-32	33	34	35	36	37	38	39	40	41	42	43	44	45-62	63	64	65	66	67	68
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Common carrier vibration	C.2.1.1	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	c	c	c	c	c	c	c	c	c	c	c	c	c						
Packaged transit drop	C.2.1.2	h		h		h	h	h	h		h			h	h	h	c		c		c	c	c	c			c	c	c						
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a						
Low temperature storage	C.1.2																x	x	x	x	x	x	x	x	x	x	x	x	x						
High temperature storage	C.1.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																			
High temperature cycling	C.1.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																			
Thermal shock	C.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c						
Air Transport Dynamics - Military	C.2.4	h	h	h		h			h		h		h		h	h	c	c	c		c		c	c		c		c	c						
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a		a			a		a		a		a	a	a	a	a		a		a	a		a		a	a						
Land Transport Dynamics - Military	C.2.2	h	h	h		h			h		h		h		h	h	c	c	c		c		c	c		c		c	c						
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	a	a	a		a			a		a		a		a	a	a	a	a		a		a	a		a		a	a						
Tactical Drop	C.2.5	h	h	h		h			h		h		h		h	h	c	c	c		c		c	c		c		c	c						
Level 2 Inspection (BIT, visual, NDT, radiography)	7.3	c	c	c		c			c		c		c		c	c	c	c	c		c		c	c		c		c	c						
Humid heat	C.1.1	x				x	x	x									x				x									x	x	x			
Solar radiation	C.1.5		x															x					x										x	x	x
Level 3 Inspection (Reduced BTCA)	7.4	a	a	a	a	a	a	a									a	a	a	a															
Dynamic Firing Tests - Free Flight	D.1.1								c	c						h					c	c	h						c	a	a	a	a	a	a
Rocket motor static firing	D.2.1										h	h	h	c	c									c	c	c	h	h							

Key:
a = ambient test h = hot conditioned test
c = cold conditioned test x = required (test temperature defined in test)

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APPENDIX B. TEST PROGRAM FOR SHOULDER LAUNCHED MUNITIONS.
ANNEX 4. GENERAL GUIDANCE FOR TESTING OF RELOADABLE LAUNCHERS.

The scope of this document is limited to munitions and does not include S3 testing of reloadable launchers. However, the following general guidance on reloadable launcher tests is provided to address munition/launcher compatibility as it applies to launch safety of the weapon system.

B.4-1. RELOADABLE LAUNCHER FAILURE MECHANISMS.

For munitions intended for use in a reloadable launcher, appropriate testing and analysis shall be performed to assess that the munition is compatible with the weapon design limits. There are two primary failure mechanisms for a reloadable launcher that potentially cause a catastrophic event: (1) the barrel fails to contain the pressure produced by the propelling charge through the entire life cycle, and (2) a crack propagates from one surface (inner to outer) wall due to fatigue.

B.4-2. RELOADABLE LAUNCHER SAFETY TEST PROGRAM.

The guidance of STANAG 4110 should be considered early in the development of the weapon system. The worst case pressure shall not exceed the design criteria for the launcher. Prior to conducting safety testing, a review of the design should already support some basis for expecting an acceptable low failure rate. The launcher safety testing should include increased severity test conditions at the maximum pressures that can reasonably be expected at the temperature extremes that may be encountered. Frequent and well defined inspection methodology should be a part of any qualification test.

B.4-2.1 Environmental Tests.

The climatic and dynamic tests defined in Appendix C are recommended for reloadable launchers. The tests should follow a sequential test flow similar to that described in Appendix B, Annex 1 with sufficient test asset quantities to provide a high degree of confidence in the safe operation of the launcher.

B.4-2.2 Operational Tests.

In addition to the dynamic firing tests defined in D.1-1, the following operational tests should be considered for reloadable launchers:

B.4-2.2.1 Fatigue Cycling.

A launcher failing by fatigue can result in a catastrophic injury to the gunner and nearby personnel. Establishing a maximum number of rounds allowed to be fired is one of the criteria for determining safe service life. Fatigue testing should be conducted in accordance with ITOP 03-2-829 to determine the fatigue life of a reloadable weapon. This includes a combination of dynamic firings and firing simulations (e.g., pressure pulsation). Completion of a validated design assessment is important to determine the Fatigue Design Pressure(s) applied to specified sections of the tube during fatigue testing. These values should be based on the worst case pressure round fired from the reloadable weapon.

APPENDIX B. TEST PROGRAM FOR SHOULDER LAUNCHED MUNITIONS
ANNEX 4. GENERAL GUIDANCE FOR TESTING OF RELOADABLE LAUNCHERS

B.4-2.2.2 Burst Tests.

The test method described in paragraph D.2-2 shall be applied to identify burst/failure characteristics of the barrel. As a minimum, the minimum burst and the maximum munition pressure-time characteristics should be compared to determine the margin of safety. A preferable approach is to measure burst pressure values along the barrel length associated with variations in wall thickness. Comparison of the burst data to the munition pressure-time data with utilization of the developer's material properties, finite element analysis, and other design data combined will determine the margin of safety. Select the munition type that produces the highest pressure-time characteristic for this assessment.

B.4-2.2.3 Max Firing Rate at Temperature Extremes.

The weapon system should be dynamically fired at the upper and lower operational temperatures at the maximum firing rate. The maximum allowable for an operational day shall be fired. Launch safety and projectile flight safety are the key safety considerations during dynamic firings. A projectile is considered launch safe if no premature warhead detonations have occurred. A projectile will be considered flight safe if the rate of early function meets the acceptable level prescribed by the requirements document or specification of the munition. Additionally, there should be no damage to the launcher or evidence of erratic flight. Round impacts that deviate greatly from the group shall be reviewed to determine the source of this atypical behaviour.

B.4-2.2.4 Reliability Firing.

Reliability testing is not specifically a safety test, but safety information can be gained. The item under test should demonstrate meeting the acceptable level of reliability prescribed by the requirements document. Data collection for reloadable weapons should include gas erosion, wear, tube roundness, and evidence of cracks. An item demonstrating unacceptable reliability should be considered for additional safety evaluation to determine if an unidentified hazard is present due to lower confidence levels.

B.4-2.2.5 Accuracy/Dispersion.

Accuracy/Dispersion testing is not specifically a safety test, but safety information can be gained. The item under test should demonstrate meeting the acceptable level prescribed by the requirements document. Attention to proper collection of data is required to ensure at the system of system level and the weapon can be safely fired with a high confidence of hitting the intended target (as to avoid friendly and collateral damage).

APPENDIX C. ENVIRONMENTAL TEST DESCRIPTIONS.

This document was developed within the international community and is written with references to both US and NATO test procedures to provide a framework for international procurement and test programs. Table I2-1 (Appendix I, Annex 2) provides cross reference of similar national and international test standards.

This appendix provides descriptions of all of the environmental (climatic and dynamic) tests required in the S3 Test Programs included in Appendix B. Annex 1 contains the climatic test descriptions; Annex 2 contains the dynamic test descriptions. Rationales for all environmental tests are provided in Appendix A.

APPENDIX C. ENVIRONMENTAL TEST DESCRIPTIONS.

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APPENDIX C. ENVIRONMENTAL TEST DESCRIPTIONS.
ANNEX 1. CLIMATIC TESTS.

C.1-1. HUMID HEAT (HOT HUMID CYCLE).

Perform Aggravated Humidity testing in accordance with MIL-STD-810, Method 507, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions when applicable.

b. Test Level: MIL-STD-810, Method 507, Figure 507.6-7 ‘Aggravated temperature-humidity cycle’.

c. Test Duration: Ten 24-hour cycles to be applied.

C.1-2. LOW TEMPERATURE STORAGE.

Perform Low Temperature testing in accordance with MIL-STD-810, Method 502, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions when applicable.

b. Test Level: Constant temperature of -51 °C. Low temperature cycling may be considered as a substitute for low temperature storage (see paragraph A.1-2.2.1).

c. Test Duration: 72 hours (3 days) continuous.

C.1-3. HIGH TEMPERATURE STORAGE.

Perform High Temperature testing in accordance with MIL-STD-810, Method 501, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions when applicable.

b. Test Level:

(1) Munitions that do not contain temperature sensitive energetic materials: Constant temperature of +71 °C for 216 hours (9 days).

(2) Munitions that contain energetic materials that are temperature sensitive (e.g., explosives based on TNT, or double/triple base propellants): Constant temperature of +58 °C for 456 hours (19 days).

C.1-4. HIGH TEMPERATURE CYCLE.

Perform High Temperature testing in accordance with MIL-STD-810, Method 501, Procedure I using the following test parameters:

APPENDIX C. ENVIRONMENTAL TEST DESCRIPTIONS.
ANNEX 1. CLIMATIC TESTS.

a. Munition Configuration: Unpackaged munitions when applicable.

b. Test Level: MIL-STD-810, Method 501, Table 501.6-III 'High Temperature Cycle Category A1' Induced Conditions (Temperatures: +33 °C to +71 °C).

c. Test Duration: 28 diurnal (24-hour) cycles to be applied.

C.1-5. SOLAR RADIATION.

Perform Solar Radiation testing in accordance with MIL-STD-810, Method 505, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions when applicable.

b. Test Level: MIL-STD-810, Method 505, Procedure I, Figure 505.6-1 'Cycling test', Category A1 (Temperatures: 32 °C to 49 °C. Irradiance: 0 W/m^2 to 1120 W/m^2.)

c. Test Duration: Seven 24-hour solar cycles to be applied.

C.1-6. THERMAL SHOCK.

Expose all munitions to the high- and low-temperature phases of the temperature shock tests in accordance with MIL-STD-810, Method 503, Procedure 1 and as described below. The aggravated thermal shock cycle may be substituted for the phased thermal shock approach described below (see paragraph A1.2.4.2). Munitions are tested in their unpackaged configuration when applicable.

a. Low Temperature Phase. Conduct five cycles of the low temperature phase temperature shock test in accordance with MIL-STD-810, Method 503, Procedure 1A and the following test parameters:

(1) The high temperature shall be 21 °C and the low temperature chamber shall be -51 °C.

(2) Munitions are to remain in each chamber until temperature stabilization is achieved (24 hours maximum).

b. High Temperature Phase. Conduct five cycles of the high temperature phase temperature shock test in accordance with MIL-STD-810, Method 503, Procedure 1A and the following test parameters:

(1) The high-temperature shall be the unpackaged SRE temperature and the low-temperature chamber shall be -5 °C.

(2) Munitions are to remain in each chamber until temperature stabilization is achieved (24 hours maximum).

C.1-7. <u>IMMERSION</u>.

a. Immersion. Perform per MIL-STD-810, Method 512, Procedure 1 on the munition in the unpackaged configuration with the following test parameters:

(1) Conditioning temperature. Shoulder launched munitions are to be preconditioned to a temperature of 27 °C above the water temperature to represent exposure to solar heating immediately prior to immersion. Shoulder launched munitions will be tested at standard ambient conditions.

(2) Depth of immersion. Apply a minimum immersion depth of one meter or as specified in the requirements document. May be applied as an equivalent pressure for shoulder launched munitions, to represent complete immersion.

(3) Duration of immersion. Munitions are to remain immersed for a period of 30-minutes.

C.1-8. <u>SALT FOG</u>.

Perform per MIL-STD-810, Method 512 on the munition in the unpackaged configuration when applicable for two cycles alternating wet-dry-wet-dry (24 hrs each).

a. Munition Configuration: Unpackaged munitions when applicable.

b. Test Levels: Use default parameters as specified in MIL-STD-810, Method 509.

c. Test Duration: Two alternating 48 hour wet-dry cycles (48 hrs/cycle).

C.1-9. <u>SAND AND DUST</u>.

Perform Sand and Dust testing in accordance with MIL-STD-810, Method 510, Procedures I (Blowing Dust) and II (Blowing Sand) using the following test parameters:

a. Munition Configuration: Unpackaged munitions when applicable.

b. Conditioning Temperature: Munitions are to be preconditioned to a temperature of +49 °C prior to exposure.

c. Test Levels:

APPENDIX C. ENVIRONMENTAL TEST DESCRIPTIONS.
ANNEX 1. CLIMATIC TESTS.

(1) Wind Blown Dust - Use default parameters as specified in MIL-STD-810, Method 510, Procedure I.

(2) Wind Blown Sand - Use default parameters as specified in MIL-STD-810, Method 510, Procedure II for material that may be used near operating surface vehicles (sand concentration = 1.1 ± 0.3 g/m^3; wind velocity = 18 to 30 m/s).

(3) There is no requirement to test Shoulder Launched munitions.

d. Test Duration: Apply default parameters as specified in MIL-STD-810, Method 510. Note that it is recommended to conduct the sand and dust tests individually.

C.1-10. RAIN/WATERTIGHTNESS.

Perform Rain/Watertightness testing in accordance with MIL-STD-810, Method 506, Procedure I using the following test parameters:

a. Munition Configuration: Unpackaged munitions when applicable.

b. Conditioning Temperature: Munitions are to be preconditioned to a temperature of 10 °C above the water temperature.

c. Test Levels: Rainfall rate = 100 mm/hour. Wind velocity = 18 m/s.

d. Test Duration: 2 hours.

C.1-11. ICING.

Perform per MIL-STD-810, Method 521 on the munition in the unpackaged configuration when applicable with medium loading (13 mm) ice thickness representing general conditions. Sea based munitions may require an ice thickness of 75 mm in cases where extremely heavy loading is possible for items on a ship deck.

C.1-12. LOW PRESSURE (ALTITUDE).

Conduct low pressure (altitude) on a packaged munition per MIL-STD-810, Method 500, Procedure I at a pressure of 56.7 kPa (4,570m equivalent altitude) for a minimum of 1 hour. This test should be conducted at ambient temperature.

C.1-13 MOLD GROWTH.

Perform per MIL-STD-810, Method 508 on the munition in the unpackaged configuration when applicable for a minimum of 28 days. This test should be conducted as a non-sequential test.

C.1-14. CONTAMINATION BY FLUIDS.

APPENDIX C. ENVIRONMENTAL TEST DESCRIPTIONS.
ANNEX 1. CLIMATIC TESTS.

Perform per MIL-STD-810, Method 504 on the munition in the unpackaged configuration when applicable. Test requirements are to be tailored according to the materials on the test article. This test should be conducted as a non-sequential test.

APPENDIX C. ENVIRONMENTAL TEST DESCRIPTIONS.
ANNEX 2. DYNAMIC TESTS.

C.2-1. LOGISTIC LAND TRANSPORTATION DYNAMICS – COMMERCIAL.

C.2-1.1 Logistic Wheeled Vehicle Transportation Dynamics.

Commercial (Common Carrier) Transportation Vibration. Perform vibration testing in accordance with MIL-STD-810, Method 514 using the following test parameters:

a. Munition Configuration: Munitions may be transported in the single munition or bulk munition (palletized) transport configuration. Selection of the test configuration may be based on available test equipment, quantity of test assets, or efficiency of test operations.

b. Test Level: Vibrate each munition in accordance with the ‘Ground Wheeled Common Carrier’ vibration schedules of MIL-STD-810, Method 514.

c. Test Duration: The vibration should be conducted for a test duration equivalent to the minimum of 4800 km in the configuration associated with the commercial logistic phase of deployment and 4800 km in the configuration associated with military logistic phase. Based on the current versions of MIL-STD-810, Method 514, the test should be conducted for a duration equivalent to the distance specified in Table A-2.

d. Test Temperature: Temperature condition the items prior to and during vibration testing. Stabilize all designated cold items to a temperature of -46 °C. Stabilize all designated hot items to the packaged SRE temperature.

Note: Although the Common Carrier vibration environment is relatively benign compared to other wheeled vehicle vibration environments, the test should not be tailored out due to the intent of loosening up the test article and packaging prior to conduct of temperature and humidity tests.

C.2-1.2 Packaged Transit Drop.

Due to the severity of this test, only half of the logistic land transportation dynamics test quantity should be subjected to the packaged transit drop.

a. Munition Configuration: This test is conducted with the munitions packaged in their logistic container.

b. Test Level: Conduct two handling drop tests on each drop test munition from height of 2.1 meters onto a concrete supported steel surface. The drop test should be conducted in accordance with MIL-STD-810, Method 516, Procedure IV.

c. Test Temperature: Temperature condition the items prior to conducting the packaged handling drop tests. Stabilize all designated cold items to a temperature of -46 °C. Stabilize all designated hot items to the packaged SRE

temperature. Any drop should be conducted within the shortest duration possible upon removal from the conditioned environment. The maximum duration should be no longer than 30 minutes. During transport from the conditioned environment to the test site, it is good practice to minimize heat transfer effects through the use of thermal mitigation measures (i.e., insulated transport box or insulating blanket).

d. Drop Orientation: The test item is to be released such that it will impact in two of the following orientations:

- major axis vertical, nose up
- major axis vertical, nose down
- major axis horizontal
- 45 ° major axis nose down
- 45 ° major axis base down

The sample size shall be subdivided to ensure at least one impact occurs in each of the orientations.

C.2-2. LOGISTIC LAND TRANSPORTATION DYNAMICS – MILITARY.

For shoulder launched munitions, military land transportation dynamics addresses the mechanical environments that may be encountered during military transportation by wheeled and tracked vehicles. When testing for wheeled, there is effectively a vibration and a shock element. Both the wheeled vehicle transportation vibration and retrained cargo shock tests must be completed. Tracked vehicle transportation is applicable to shoulder launched munitions. All possible vehicle types must be addressed in order to satisfy the S3 objectives for Logistic Land Transportation Dynamics for Military Vehicles.

C.2-2.1 Military Wheeled Vehicle (Tactical/Composite Wheeled Vehicle) Transportation Vibration.

Perform vibration testing in accordance with MIL-STD-810, Method 514 using the following test parameters:

a. Munition Configuration: This test should be conducted on individual munitions in the appropriate military transport and tie-down configuration for each phase of deployment.

b. Test Level: MIL-STD-810, Method 514, Figure 514.7C-4, ‘Category 4 – Composite wheeled vehicle vibration exposure’.

For each deployment, this vibration test should be conducted for a test duration

equivalent to the minimum of 800 km in the configuration associated with the logistic phase of deployment and 800 km in the configuration associated with tactical deployment. Based on the current versions of MIL-STD-810, the logistic test duration is 40 minutes/axis and the tactical deployment test duration is 40 minutes/axis as calculated in Table A-2.

c. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the appropriate SRE temperature.

C.2-2.2 Restrained Cargo Transport Shock.

Perform shock testing in accordance with MIL-STD-810, Method 516 using the following test parameters:

a. Munition Configuration: This test should be conducted on individual munitions in the appropriate military transport and tie-down configuration for each phase of deployment.

b. Test Level: All shocks stated in Table C2-1 shall be applied in each sense of each orthogonal axis. In accordance with MIL-STD-810, the shock pulse is terminal peak sawtooth. Half-sine pulses may be substituted for the levels specified in Table C2-1 if it can be shown to produce equivalent velocities. Furthermore, a synthesis based on the corresponding shock response spectrum (SRS) that encompasses both senses of each axis may also be substituted. MIL-STD-810, Method 516 provides guidance for SRS methods.

c. Number of Shocks: The required number of shock repetitions are stated in Table C2-1.

d. Test Temperature: Temperature condition the test munitions prior to, and during shock testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the appropriate packaged or unpackaged SRE temperature.

TABLE C2-1. RESTRAINED CARGO TRANSPORT SHOCK LEVELS

MILITARY VEHICLE - LAND MUNITIONS (800 KM)	
Terminal Peak Sawtooth	
Duration: 5 ms	
Amplitude (g pk)	Number of Shocks
10.2	34
12.8	17
15.2	3

NOTE: The number of shocks has been tailored from MIL-STD-810, Method 516 values to arrive at the equivalent transport distance for each vehicle and munition type. All shocks are to be applied in each sense of each orthogonal axis.

APPENDIX C. ENVIRONMENTAL TEST DESCRIPTIONS.
ANNEX 2. DYNAMIC TESTS.

C.2-2.3 Two Wheeled Trailer Vibration.

This test is applicable to small land munitions for which the two wheeled trailer is a plausible mode of transport. Perform vibration testing in accordance with MIL-STD-810, Method 514, Category 4 for 'Two Wheeled Trailer' using the following parameters.

a. Munition Configuration: This test should be conducted on individual munitions in the appropriate military transport and tie-down configuration for each phase of deployment.

b. Test Level: This environment can be addressed by the vibration profiles in MIL-STD-810, Method 514, Category 4 for 'Two Wheeled Trailer' using a duration equivalent to the distance specified in the LCEP.

c. Test Duration: The vibration should be conducted for a test duration equivalent to the minimum of 50 km in the configuration associated with the logistic phase of deployment and 50 km in the configuration associated with tactical deployment. Based on the current versions of MIL-STD-810, the logistic test duration is 32 minutes/axis and the tactical deployment test duration is 32 minutes/axis as calculated in Table A-2.

d. Test Temperature: Stabilize all cold munitions to -46 °C and all hot munitions to the appropriate packaged or unpackaged SRE temperature prior to vibration testing. Test temperature is to be maintained throughout vibration testing.

C.2-2.4 Loose Cargo.

a. Test Temperature: Stabilize all cold munitions to -46 °C and all hot munitions to the unpackaged SRE temperature prior to testing. Test temperature is to be maintained throughout testing.

b. Munition Configuration: This test should be conducted on individual munitions in the appropriate military transport and tie-down configuration for tactical deployment. .

c. Test Procedure: Conduct the loose cargo test in accordance with MIL-STD-810, Method 514, Category 5.

d. Test Duration: This test should be conducted for test duration equivalent to the minimum of 250 km. Based on the current version of MIL-STD-810, the test duration is 20 minutes/axis as calculated in Table A-2. Half of the test duration should be with the munition in the horizontal orientation and the other half with the munition in the vertical orientation. Furthermore, half of the vertical duration should be forward end up and the other half with the forward end down.

APPENDIX C. ENVIRONMENTAL TEST DESCRIPTIONS.
ANNEX 2. DYNAMIC TESTS.

C.2-2.5 Tracked Vehicle Transportation Vibration.

Perform vibration testing in accordance with MIL-STD-810, Method 514 using the following test parameters:

a. Munition Configuration: This test should be conducted on individual munitions in the appropriate military transport and tie-down configuration for tactical deployment.

b Test Level: This environment can be addressed by the vibration profiles in MIL-STD-810, Method 514 and TOP 01-2-601 using a duration equivalent to the distance specified in the LCEP.

c. Test Duration: The vibration should be conducted for a test duration equivalent to the minimum of 1000 km. Based on the current version of MIL-STD-810, the test duration is 281 minutes/axis as calculated in Table A-2.

d. Test Temperature: Stabilize all cold munitions to -46 °C and all hot munitions to the unpackaged SRE temperature prior to vibration testing. Test temperature is to be maintained throughout vibration testing.

C.2-3. MILITARY SEA TRANSPORTATION DYNAMICS.

C.2-3.1 Shipboard Shock (UNDEX).

Perform UNDEX testing in accordance with MIL-S-901 using the following test parameters:

a. Munition Configuration: Packaged.

b. Test Level: Test parameters are to be determined by National Authority to ensure Safe for Disposal requirements are met. Guidance can be found in NATO publications ANEP-43, STANAG 4549 and STANAG 4150.

c. Test Temperature: Temperature condition the test munitions prior to, and during shock testing. Stabilize at +21 °C.

d. This test should be conducted as a non-sequential test on a single tactical transportation package if the criteria is ‘safe for disposal’, or during the LCEP life cycle test sequence on selected munitions if the criteria is ‘safe for use’.

C.2-4. LOGISTIC AIR TRANSPORTATION DYNAMICS – MILITARY.

Military Air Transportation Dynamics addresses the mechanical environments that may be encountered during military transportation by fixed wing aircraft (propeller and jet) and helicopters. All tests under these sections must be completed in order to satisfy the S3 objectives for Military Air Transportation unless the mode of transportation is not applicable to

the munition under test.

C.2-4.1 Fixed Wing Aircraft Cargo Transportation Vibration.

Fixed Wing Aircraft Transportation includes both Turboprop and Jet Aircraft Vibration as described in the following paragraphs.

C.2-4.1.1 Fixed Wing Turboprop Aircraft Transportation Vibration.

Perform vibration testing in accordance with MIL-STD-810, Method 514 using the following test parameters:

a. Munition Configuration: Packaged.

b. Test Level: MIL-STD-810, Method 514, Appendix C, for ‘Propeller Aircraft’ for C130K (4-blade, f_0=68 Hz) and C130J (6 blade, f_0=102 Hz), with L_0 = 1.2 g^2/Hz for f_0. Other aircraft types may be added if their fundamental blade passing frequencies (f_0 component) are known.

c. Test Duration: The test should be conducted for a total test duration equivalent to the flight duration specified in AECTP 100, Annex E, Appendix 1 for transportation by ‘Turboprop Aircraft’ for either Land Vehicle Mounted Missiles or Sea Launched Missiles. Based on the current versions of AECTPs 100 and MIL-STD-810, the test duration is one hour per axis as calculated in Table A-3. The test duration for a stated axis should be split such that each set of blade passing frequencies are addressed equally. (For C130 only, this would require the total test duration to be divided equally between the two blade passing frequencies of 68 Hz and 102 Hz).

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature.

C.2-4.1.2 Fixed Wing Jet Aircraft Transportation Vibration.

Perform vibration testing in accordance with AECTP 400, Method 401, Procedure III using the following test parameters:

a. Munition Configuration: Packaged.

b. Test Level: MIL-STD-810, Method 514, Appendix C for ‘Jet Aircraft Cargo’.

c. Test Duration: The test should be conducted for a total test duration equivalent to the flight duration specified in AECTP 100, Annex E, Annex 1 for transportation by ‘Jet Aircraft’ for man portable missiles. Since the test level is for the take-off environment only, the test duration is based on the number of

flights. To derive appropriate test durations, apply an average flight time of 10 hours per transport to determine the appropriate number of take-off events. Based on the current versions of AECTPs 100 and MIL-STD-810, the test duration is 10 minutes per axis as calculated in Table A-3.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature.

C.2-4.2 Helicopter Cargo Transportation Vibration.

This test is applicable to all shoulder launched munitions for which transport as cargo on a Rotary Wing Aircraft is a plausible mode of transport. Perform vibration testing in accordance with MIL-STD-810, Method 514 using the following test parameters:

a. Munition Configuration: Packaged.

b. Test Level: MIL-STD-810, Method 514, Appendix C for 'General' Materiel. Blade passing frequencies of 11 Hz, 17 Hz, and 21 Hz should be used to address most transport helicopter types. Other aircraft types may be added if their fundamental blade passing frequencies (f_1 component) are known. Modify the default sine and random vibration levels specified in MIL-STD-810, Method 514 as needed for the test duration in C.2-4.2c using the equivalent fatigue guidance provided in MIL-STD-810 Method 514.

c. Test Duration: The test should be conducted for a total test duration equivalent to a minimum flight duration of 10 hrs. To be consistent with the current version of AECTP 400, Method 401, the test duration is 1.5 hours/axis. The total test duration for a stated axis should be split such that each set of blade passing frequencies are addressed equally.

d. Test Temperature: Temperature condition the test munitions prior to, and during vibration testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the packaged SRE temperature.

C.2-5. TACTICAL DROP/IMPACT.

Subject at least half of all sequential test munitions to the Tactical Handling Drop Test with criteria of Safe for Use. Perform drop testing in accordance with MIL-STD-810, Method 516 using the following test parameters:

a. Munition Configuration: The sample should subdivided such that half the items are dropped in the unpackaged configuration and half the items are dropped in the ready-to-fire configuration. Drop tests in the ready-to-fire configuration may not be required if a known failure mode will occur that would obviously render

the munition inoperable (e.g. shattered seeker). In this case, all drops would be in the unpackaged configuration.

b. Test Level: Conduct unpackaged handling drop in accordance with MIL-STD-810, Method 516, Procedure IV (Transit Drop). Drop each item two times from height of 1.5 meters onto a concrete-supported steel surface.

c. Drop Orientation: Drop each item two times. The test item is to be released such that it will impact in two of the following orientations:

- Major axis horizontal.

- Major axis vertical, nose up / base down.

- Major axis vertical, nose down / base up.

- Major axis 45°, nose up / base down.

- Major axis 45°, nose down / base up.

The sample size shall be subdivided to ensure at least one impact occurs in each of the orientations.

d. Test Temperature: Temperature condition the test munitions prior to testing. Stabilize all cold munitions to -46 °C, and all hot munitions to the unpackaged SRE temperature. Any drop should be conducted within the shortest duration possible upon removal from the conditioned environment. The maximum duration should be no longer than 15 minutes. During transport from the conditioned environment to the test site, it is good practice to minimize heat transfer effects through the use of thermal mitigation measures (i.e., insulated transport box or insulating blanket).

C.2-6. LOGISTIC DROP (12-METRE) - SAFE FOR DISPOSAL.

Subject three (3) test munitions to the Logistic Drop Test with a criterion of Safe for Disposal. Perform drop testing in accordance with MIL-STD-2105 using the following test parameters:

a. Munition Configuration: The munitions are tested in the packaged configuration unless the potential exists for munitions to be handled out of the shipping container while on naval vessels. In this case the munitions are required to be tested in the unpackaged mode.

b. Test Level: One drop of 12 m onto a concrete supported steel surface.

c. Drop Orientations: Each test munition to impact in one of the following orientations. (Note sample size should be sufficient to ensure that all

orientations are addressed):

(1) Major axis horizontal

(2) Major axis vertical, nose up / base down

(3) Major axis vertical, nose down / base up

d. Test Temperature: Ambient

APPENDIX D. OPERATING TEST DESCRIPTIONS.

This annex provides descriptions of all of the firing and operating tests required in the S3 Test Programs included in Appendix B. Rationales for these tests are provided in Appendix A.

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APPENDIX D. OPERATING TEST DESCRIPTIONS.
ANNEX 1. FIRING SAFETY TESTS.

The firing safety tests are performed upon completion of the sequential environmental tests. All of these tests are conducted remotely with the munition temperature conditioned to the appropriate temperature. The low-temperature test items are to be temperature stabilized to -46 °C prior to performing the firing tests. The high-temperature test items are to be temperature stabilized to 63 °C or the unpackaged SRE temperature, whichever is higher, prior to performing the firing tests. Firing tests should be conducted within the shortest duration possible upon removal from the conditioned environment. The maximum duration should be 15 minutes.

D.1-1. DYNAMIC FIRING.

The dynamic firing tests are conducted on an instrumented firing range to demonstrate that the munition: is safe to launch (does not eject hazardous debris or detonate upon ignition), safely separates from the launch point/tube, and travels at and explosively functions at trajectories which cause no additional hazards to the firing crew. Damaged test munitions will be fired if it is judged by the tester that troops in the field would have overlooked or considered the damage negligible and fired the item. Performance data shall be recorded but not used as acceptance criteria except as related to safety. Additional data is collected to support the Weapon Danger Area and Health Hazard Analyses.

a. Record launch, early flight, and air burst or target impact portions of the flight with high-speed cameras, radars, or infrared sensors. Record fire control and ground signals. Obtain air burst data, munition position and velocity data and, as applicable, miss distance data for these firings.

b. Health Hazard Analysis. Collect applicable health hazard data as required for the intended platform(s). Consider acoustic energy, blast overpressure, launch blast debris, toxic substances (toxic gases and particulates), thermal effects, radiation, and launch shock (recoil) data in accordance with Appendix H, Annex 2. These data are collected at positions to be occupied by the launch crew. Also collect these data outside of the firing position to define the launch space that is unsafe for occupancy during firings. The Health Hazard Analysis will require a Toxicity Clearance for new chemicals and formulations which will address toxic gases and combustion byproducts.

c. Weapon Danger Area Analysis. Plot all munition impact coordinates (measured during successful and unsuccessful dynamic firings) on weapon danger area profiles. Develop statistical density distributions of the impacts for assessment of the specified weapon danger area profiles and the firing range safety profiles. Use warhead arming and functioning data from the unmanned firings and the warhead arena trials (Appendix D, Annex 2, Paragraph D.2-4), combined with munition impact data and weapon danger area profiles, to assess launch area safety and downrange safety, including friendly soldier overflight safety, as applicable. Further guidance may be found in STANAG 2240, Allied Range Safety Publication 1 (ARSP-1 VOL II) Weapon Danger Areas / Zones For Unguided Weapons For Use by NATO Forces in a Ground Role.

APPENDIX D. OPERATING TEST DESCRIPTIONS.
ANNEX 1. FIRING SAFETY TESTS.

D.1-2. FUZE ARMING DISTANCE FIRING.

Fuze arming distance firings are used in combination with warhead arena trials to verify that the no-arm or "minimum arm distance" exceeds the safe separation distance for the item. Detailed guidance may be found in the MIL-STD-331. Consider anticipated launch scenarios (e.g., platform velocity, launch attitude, maneuvers) in planning fuze arming tests and analysis.

a. Fuzes function in two primary modes: point detonating and air burst, others may include a delay feature. The Projectile Fuze Arming Distance procedure of MIL-STD-331 Test D2 is used to determine the minimum arm distance for point detonating and delay type fuzing systems. For an air burst type fuzing system, the minimum arm distance is determined using the Time to Air Burst test approach in MIL-STD-331 Test D3.

b. Fire items at an instrumented range and record launch, early flight, and air burst or target impact portions of the flight with high-speed cameras, radars, or infrared sensors. Record fire control and ground signals, as well as target configuration and distance from launch point. Obtain time to burst data, munition position, and velocity data and, as applicable, miss distance data for these firings.

D.1-3. WARHEAD FUZE SENSITIVITY.

Fuze sensitivity tests determine whether or not the fuze functions on impact with light brush or other obstruction in close proximity to the firing crew. A fly-through panel is placed at predetermined distances to simulate obstructions. MIL-STD-331 provides details on this and other fuze sensitivity tests. Some of the munitions may be fired at extreme temperatures.

D.1-4. FIRE FROM ENCLOSURE.

This is a special case of the free flight firing test in which munitions are fired out of specially designed rooms or enclosures. The test provides data to allow the subsequent assessment of the minimum size room from which a weapon may be fired without harming the occupants of the room. Most shoulder launched munitions will require this test. Review weapon operational scenarios to determine its applicability. For further guidance, refer to ITOP 05-2-517 (Fire from enclosure) and ITOP 05-2-502 (Toxic gasses in missiles and rockets).

a. Health and Safety Hazard Analysis. Acoustic noise, blast overpressure, toxic substances, oxygen depletion and launch debris are the primary data obtained from the test. The configuration of the 'Fire from Enclosure' room should be well documented to ensure the data is reduced properly. The following information with respect to the room should be recorded:

i. Total room volume (length, width, and height). Objects of significant volume such as weapon launch fixture base, anthropomorphic

dummies, large cameras, etc. would be subtracted from room volume.

ii. Total vented area (firing window, doors, and other windows).

iii. Window/Door positions measured with respect to rear of launch tube and with respect to projectile tube exit location.

iv. Secondary room volume (if applicable) and its position with respect to primary room. Also determine the vented area connecting to primary room.

v. Transducer locations relative to walls, weapon, ceiling, floor and the type of mounting (tripod / anthropomorphic)

vi. Toxic substance collector locations relative to walls, weapon, ceiling, floor and the type of mounting (tripod / anthropomorphic)

b. Install all transducers and collectors in the ‘Fire from Enclosure’ room. Position the weapon in the remote firing stand. Fire the weapon remotely. Record and analyze the data to determine hazards to the operator. Attention should also be paid to rearwards effects such as efflux and projected debris from propulsion systems.

APPENDIX D. OPERATING TEST DESCRIPTIONS.
ANNEX 2. COMPONENT LEVEL OPERATING TESTS.

Munitions that have undergone sequential environmental testing require component level assessment of energetic and pressure vessel components in order to estimate the probability and effect of catastrophic failure during operational use. In addition to warheads and rocket motors, other items may require these tests. Examples are gas generators, pressure vessels, or thermal beacons which could burst during operation and present a hazard to personnel. See Appendix A, Annex 2 for additional background and rationale.

D.2-1. ROCKET MOTOR STATIC FIRING.

Static firings are conducted to measure the internal operating pressure of rocket motors during operational use. Guidance for this test may be found in International Test Operations Procedure (ITOP) 05-2-500.

a. The items should be temperature conditioned to -46 °C and the higher of +63 °C or the unpackaged SRE temperature.

b. Mount the item in an appropriate static firing stand.

c. Instrument item with pressure, force, strain, temperature, and vibration transducers as required.

d. Static fire item and record internal operating pressure, thrust, strain, temperature, and acceleration parameters as required.

e. Perform a post test inspection of the motor to check for ‘burn-through’ of rocket motor case, heat damage to nozzle/venturi and damage to thermal barrier (if present).

f. The probability of motor case rupture is estimated using the static firing and burst test pressure data in the statistical method presented in Appendix G.

g. Margins of safety must be demonstrated between measured test data and measured or analytical failure modes. If measured variable data indicate only small margins of safety exist, further investigation or testing may be required.

D.2-2. ROCKET MOTOR BURST TESTS.

Burst tests are conducted to measure the pressure required to burst the rocket motor case under conditions similar to actual firing. These tests are conducted at ambient temperature using the hydrostatic burst test method described below.

a. Position the item in an appropriate restraining fixture and instrument with pressure transducers to record the internal operating pressure.

b. Fill the rocket motor completely with an inert test fluid such as water.

APPENDIX D. OPERATING TEST DESCRIPTIONS.
ANNEX 2. FIRING SAFETY TESTS.

c. Using a high-pressure pump or a bursting diaphragm arrangement, rapidly pressurize the vessel until it bursts. Note that the fluid line should have provisions for an additional volume of test fluid to be pumped into the vessel to account for motor case expansion. The rate of pressurization shall approximate the pressurization rate of a normally fired motor.

d. Perform a post test inspection of the motor case to check for indications of structural failure.

e. The probability of motor case rupture is estimated using the static firing and burst test pressure data in the statistical method presented in Appendix G. Further guidance on bursts test methods may be found in ITOP 05-2-621.

D.2-3. OTHER PRESSURE VESSELS.

Other types of pressure vessels in the weapon system (gas generators, high pressure pneumatic vessels, etc.) are hydrostatically burst tested to assess personnel hazards and determine safety design margins. Compare burst pressures to determine the safety margin and the likelihood of burst. Determine the fragment size, the velocity, and the fragment distribution to assess the hazard in the event of burst during service use of the vessel.

D.2-4. WARHEAD ARENA TRIALS.

Warhead arena trials are performed to provide the spatial distribution of fragments. Modelling using this data is conducted to determine safe separation distances and range safety parameters. These trials should be conducted with non-sequential, factory fresh warheads unless it can be shown that exposure to thermal and dynamic stresses in the Sequential Environmental Test Sequence results in an increase in fragmentation distance. Guidance for this test can be found in ITOP 04-2-813.

a. Perform this test on four individual warheads at ambient temperature.

b. Warhead arena trials require the use of the warhead only. However, the tester should evaluate whether components directly attached to the warhead or in the immediate area of the warhead, either by design or by inadvertent action, could significantly affect the warhead's fragment dispersion pattern.

c. Place the item in the instrumented arena and detonate the warhead.

d. Determine warhead fragment size, velocity, mass, spatial distribution, and levels of noise and blast pressure.

D.2-5. OTHER ENERGETICS.

APPENDIX D. OPERATING TEST DESCRIPTIONS.
ANNEX 2. COMPONENT LEVEL OPERATING TESTS.

Other types of energetic materials in the munition (e.g., thermal batteries, safe and arming devices, squibs) are static fired to assess functionality with respect to safe operation. Ten of each type of energetic device in the munition shall be static fired.

D.2-6. OTHER SAFETY CRITICAL COMPONENTS.

Conduct operational tests on safety critical components to the extent required to identify potentially unsafe operation. Ten of each safety critical component shall be operationally tested.

APPENDIX D. OPERATING TEST DESCRIPTIONS.
ANNEX 2. FIRING SAFETY TESTS.

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APPENDIX E. BREAKDOWN TEST AND CRITICAL ANALYSIS (BTCA).

This document was developed within the international community and is written with references to both US and NATO test procedures to provide a framework for international procurement and test programs. Table I2-1 (Appendix I, Annex 2) provides cross reference of similar national and international test standards. The following BTCA procedures must only be conducted by suitably qualified and experienced personnel.

E.1. GENERAL INSPECTION.

Prior to disassembly for BTCA, conduct a thorough review of Level 1 (basic visual) and Level 2 (radiography) inspection results and non-functioning test results obtained throughout the sequential environmental trial. Any anomaly should be carefully considered with regard to the safety of the munition disassembly and BTCA processes.

E.2. BREAKDOWN AND ANALYSIS REQUIREMENTS.

E.2-1 Applicability.

The following tests are broadly applicable to warheads (main charge and firing train), rocket motors (main charge, igniter, intermediaries) and pyrotechnic devices (actuators, tracers, etc.).

E.2-2 Requirement Considerations.

The exact requirements for BTCA need to be determined on a case by-case basis taking into consideration the degree of novelty and/or complexity of the munition. They will be determined by known failure modes and life limiting factors for comparable munitions.

E.2-3 Baseline Test Considerations.

Prior to commencement of all trials, at least one munition from the same batch/lot as those undergoing the sequential environmental trial should be disassembled and analyzed to identify potential failure modes that may occur. This sets the baseline for comparison against the environmentally stressed munitions. There should also be baseline munitions for the functioning (dynamic and static firing) tests. It may also be possible to use the results from material Qualification tests (to STANAG 4170) for baseline purposes, or data from material manufacturers batch/lot acceptance tests provided these give data equivalent to that from the Qualification tests. Furthermore, firing data from development trials may be used for baseline purposes provided the munition is of the same build standard as the test munitions and provides the required data. However, it should be noted that none of these latter options will permit comparison against the physical condition of the munitions following the sequential environmental trial.

E.2-4. TEST CONSISTENCY CONSIDERATIONS.

It is essential to ensure that the same test procedures used to determine the baseline properties of materials are used during BTCA.

APPENDIX E. BREAKDOWN TEST AND CRITICAL ANALYSIS (BTCA).

E.2-5. CONTAMINATION CONSIDERATIONS.

During disassembly and material extraction, care must be taken to ensure that the extracted samples do not become contaminated (by structural materials or other matter) and/or physically damaged/changed (e.g., compressed, cracked, abraded).

E.2-6. FUNCTIONAL TEST CONSIDERATIONS.

Small items such as igniters, initiators, squibs, etc. pose particular difficulties during disassembly, and it may not be possible to extract sufficient material without damaging the material contained within. In such cases it is acceptable to perform just visual and radiographic inspection followed by functioning tests (at extremes of service temperature). This should include electrical resistance checks and tests performed during lot acceptance such as performance tests during functioning. In some cases it may be possible to extract sufficient material to perform small scale tests such as volatile content determination or differential scanning
calorimetry (DSC).

E.2-7. BTCA TEST REQUIREMENTS.

The aspects below are provided as an indication of the types of testing required.

E.2-7.1 Inspection and Disassembly.

a. Physical integrity and dimensional checks of the munition, sub-systems, energetic materials, and structural materials. This can be achieved through visual inspection (including photography as required), radiography, Computed Tomography (CT) Scan, Dye Penetrant, Bore-scope (for rocket motor conduits), Ultrasonic inspection, and/or Fluoroscopy both prior to, and following disassembly. Some techniques may be more applicable to structural materials which must also be assessed. Dimensional checks should assess physical dimensions and mass of the complete munition, sub-systems and energetic materials to demonstrate compliance with specifications/drawings.

b. During disassembly, pay particular attention to signs of cracking, surface crystallization/dusting (e.g., Ammonium Perchlorate in rocket motors and Nitramines in warheads), debonding/delamination (e.g., thermal liners and inhibitors for rocket motors), exudation (e.g., energetic and inert plasticizers in rocket motors), corrosion, discoloration, wear, missing components and other damage.

c. Plastics, rubbers, foams, seals etc. should be examined for signs of degradation or uptake of plasticizer. ‘O’ rings should be examined for compression set and that they still meet their specification requirements.

APPENDIX E. BREAKDOWN TEST AND CRITICAL ANALYSIS (BTCA).

E.2-7.2 Chemical Tests.

a. Chemical composition, including total volatile matter and moisture content, must be assessed to demonstrate compliance with specifications/drawings.

b. Chemical stability must be assessed for all energetic materials, although the tests used will be material dependent. The vacuum stability test is particularly applicable for main charge explosives. Chemical stabilizer depletion testing (to AOP-48) is applicable for nitrate-ester propellants, with a preference for multi-temperature ageing since this gives both stabilizer content and chemical kinetics.

E.2-7.3 Compatibility Tests.

a. Chemical/explosive compatibility between all components of construction with the explosives they will be in communication with (both in physical contact and by gas/vapor path) should have been assessed during material qualification and/or design of the munition. This compatibility data shall be presented as a matrix that lists the materials, and for each explosive declares whether there is communication or not with evidence to support the claim of compatibility where communication is expected.

b. During BTCA, any material incompatibilities and/or migration of explosive species are likely to become evident during inspection. Any such anomalies observed shall be noted and assessed further to address whether the munition remains safe as defined JOTP-1. An example is the migration of energetic plasticizers into thermal liners in rocket motors which may render the thermal liner incapable of fulfilling its intended design role and give rise to an unsafe situation.

E.2-7.4 Physical Properties – Explosives.

a. Assessment of flow properties and particle size distribution for granular materials (such as granular propellants and some pyrotechnic compositions), checking for coagulation of granular materials, ‘slump’ (particularly in propellants), bulk cracking, and surface cracking/crazing.

b. Thermal analysis methods, especially Differential Scanning Calorimetry, are useful tools that may indicate changes in the material over time and are particularly suited to subsequent comparison during In-Service Surveillance. They are applicable to most explosive materials, especially pyrotechnics, since they can be performed on small samples of material.

E.2-7.5 Mechanical Properties.

Mechanical properties (such as tensile/compressive/ shear strength and hardness) of explosive materials must be assessed at the full range of working temperatures for the munition. It will

also be necessary to test structural materials at temperature extremes for safety critical items, such as rocket motor cases, in order to verify design safety margins. Typical methods will include uniaxial tensile testing to STANAG 4506, Dynamic Mechanical Thermal Analysis (DMTA) to STANAG 4540 and burst overpressure tests on rocket motor cases (although it may prove difficult to conduct these as part of BTCA). It may also be necessary to assess fatigue crack growth for some structural materials. The types of testing will ultimately be determined by the type of material being tested.

E.2-7.6 Hazard Properties.

a. Repetition of the small scale tests to assess hazard properties must be undertaken. These may include, but are not limited to, methods to determine ease of initiation by impact, friction and electrical spark, along with temperature of ignition. Explosive material testing and assessment should be conducted in accordance with STANAG 4170 and AOP-7.

b. Normally the small scale tests will be sufficient but larger scale tests may also be required if an issue is identified. The exact methods used would depend upon the type and quantity of material available for the tests but may include ‘gap tests’ and tests to assess Velocity of Detonation. However, they may ultimately require full scale (i.e., complete round) tests to assess the IM properties of the munition following environmental exposure.

E.2-7.7 Electrical Components.

a. Where the munition contains electrical sub-assemblies (e.g., electronic safe/arm device, weapon controller, seeker) these should be removed during BTCA for inspection and functional checks. Functional checks should be performed initially on the initial sub-assembly, using the factory test specification. Where this is not possible or does not allow full testing, then the sub-assembly may require further disassembly to permit such testing.

b. Following this, full disassembly should be conducted for detailed component level inspection. Specific points to observe are broken/loose joints (connectors and solder), damaged/broken components, damaged/broken circuit board tracks, abraded/broken cables/wiring, corrosion, dendritic growth (e.g., ‘tin whiskers’), condition of ‘potting’ compound (if present), and burst batteries.

c. Electrical resistance of igniters/EIDs (EEDs) should be checked, and EIDs (EEDs) functioned using a normal firing pulse.

E.2-7.8 Fuze (Mechanical) Components.

a. Where the munition contains a mechanical fuze this should be removed during BTCA for inspection where possible.

APPENDIX E. BREAKDOWN TEST AND CRITICAL ANALYSIS (BTCA).

b. If there is any doubt regarding the safe and reliable function of the fuze, or it cannot be demonstrated by alternative means, it may be necessary to carry out tests that simulate the various external stimuli required to arm the fuze (e.g., acceleration, spin).

c. The fuze (either armed or safe) should be disassembled to determine its internal physical condition and verify its safe condition.

APPENDIX E. BREAKDOWN TEST AND CRITICAL ANALYSIS (BTCA).

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APPENDIX F. FACILITIES AND INSTRUMENTATION REQUIREMENTS.

This document was developed within the international community and is written with references to both US and NATO test procedures to provide a framework for international procurement and test programs. Table I2-1 (Appendix I, Annex 2) provides cross reference of similar national and international test standards.

TABLE F-1. FACILITY REQUIREMENTS

ITEM	REQUIREMENT
Inspection and Non-Destructive Test (NDT) Facility	Material inspection equipment such as video borescope, ultrasonic, and radiographic must be available to determine the condition of the munition and its components before and after exposure to environmental tests. Facility should have the capability to conduct radiographic inspection of munitions at low temperature extremes or within 15 minutes of removal from a conditioning chamber.
Climatic Test Facility	• Climatic chamber equipment capable of temperature conditioning live munitions to the extremes of -55 to 75 °C and relative humidities from 5 to 95%. • High temperature chamber for live munitions equipped with solar lamps capable of at least 1120 W/m^2 output. • Altitude chamber capable of 57 kPa or 8.3 psia on live munitions. • Equipment capable of conducting Sand and Dust, Salt Fog, Rain/Watertightness, Immersion, and Icing tests on live munitions. • Equipment capable of conducting Mold Growth and Contamination by Fluids tests on inert test articles.
Dynamic Test Facility	Equipment suitable for simulating the full range of dynamic environments (e.g., transportation shock and vibration, tactical shock and vibration, drop test) expected during the munition's lifetime. Facility should have the capability to conduct shock and vibration tests at temperature extremes and drop tests within 15 minutes of removal from a conditioning chamber.
Static Firing Test Facility	Remotely located site capable of measuring motor thrust, pressure, strain, acceleration, and temperature data as a function of time. Facility should have the capability to conduct static firing tests at temperature extremes or within 30 minutes of removal from a conditioning chamber.
Burst Test Facility	Isolated location having remotely controlled pressure generating equipment and capable of measuring pressure and strain data on inert motor cases.
Firing Range	Selected to suit missile and rocket test requirements and to provide adequate protection for personnel and equipment. Facility should have the capability to conduct firing tests at temperature extremes or within 30 minutes of removal from a conditioning chamber.

APPENDIX F. FACILITIES AND INSTRUMENTATION REQUIREMENTS.

TABLE F-1. FACILITY REQUIREMENTS (CONTINUED)

ITEM	REQUIREMENT
Warhead Test Area	Test area must have an adequate surface safety danger zone, including overhead air space for open field testing.
Munition Disassembly	Facility suitable for disassembly of live munitions for detailed inspection and component level testing.
Energetic Material Extraction	Equipment suitable for the extraction of energetic material samples for chemical analysis.
Chemistry Laboratory	Equipment suitable for the conduct of the chemical analysis tests set out in STANAG 4170, AOP-7, and paragraphs E.2-7.2 through E.2-7.6 of Appendix E (BTCA).
Electromagnetic Radiation Test Facility	Facility suitable for the generation of the specified field intensities with an adequate test volume for the test of the munition and launcher as required by the stockpile to launch configuration.
Electrostatic Discharge Test Facility	Facility suitable for the generation of the required ESD environments and large enough for the munition and launcher as required by the stockpile to launch configuration.
Lightning Test Facility	Facility capable of conducting the required lightning strike test on live or inert munitions.
Data Collection/Processing Facility	Test data shall be recorded on Digital Recorders for post-test processing. The data processing system shall edit, display, and print out the desired data plot for analysis and reporting purposes.
Video/Photographic	Closed circuit video is required for personnel safety to permit observation of munition tests. Video Camera/Recording Systems having a sufficient frame rate to record and playback desired events. High speed digital cameras and/or UV/IR cameras may also be required.

APPENDIX F. FACILITIES AND INSTRUMENTATION REQUIREMENTS.

TABLE F-2. MEASUREMENT TOLERANCES

DEVICES FOR MEASURING	MEASUREMENT TOLERANCE
Pressure	± 5 percent of the value or ± 200 Pa, whichever is greater.
Strain	± 5 percent of highest expected value
Thrust (Load Cells)	± 1 percent of highest expected value
Heat Flux	± 1 percent of highest expected value
Resistance (Low Current Circuit Tester/ Squib Tester)	± 0.05 ohms
Firing Pulse (Automatic Fire Control System)	As required for the initiation of static fire or burst tests and the automatic sequencing of the data collection systems.
Motor Ignition Events (Video)	Frame rate sufficient to record desired event.
Time	± 1 percent
Temperature Climatic Temperature Measurements Static Fire/Burst Temperature Measurements	 ± 2 °C ± 5 °C
Relative Humidity	± 5 percent
Solar Radiation	± 20 W/m ^{2}
Vibration Acceleration	See MIL-STD-810 Method 514
Acoustic Sound Pressure Level	See MIL-STD-1474
Mechanical Shock	See MIL-STD-810 Method 516
Toxic Substances (NO, NO_2, CO, CO_2, SO_2, HCL, HCN, Pb)	2 percent of full scale
Particulates (0.5-15 microns)	2 percent of full scale
Pyrolysis products (fluoride, chloride, bromide, cyanide, aldehydes)	2 percent of full scale
Length	± 1 percent
Weight	± 1 percent
Meteorological Conditions Temperature Relative Humidity Barometric Pressure UV Radiation Potential Lightning/Severe Weather Wind	 ± 2 °C ± 3 percent ± 0.25 mm of Hg ± 20 W/m ^{2} > 2 km ± 3 km/hr

APPENDIX F. FACILITIES AND INSTRUMENTATION REQUIREMENTS.

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APPENDIX G. MARGIN OF SAFETY CALCULATIONS FOR PRESSURE VESSELS.

G.1. GENERAL.

This annex provides a statistical procedure to determine, at a suitable level of confidence, that the probability of the motor case rupturing is less than some predetermined small value. The probability of case rupture is determined from two measured parameters, the maximum operating pressure of the motor, and the pressure required to rupture the motor case. The reliability of the motor case is estimated by determining the probability that the strength of the motor case exceeds the stresses exerted on the motor case.

G.2. CONFIDENCE COEFFICIENT.

An estimate of the probability of motor case rupture is determined from a relatively small sample size, which is assumed to be randomly selected from the total population. A confidence interval with an associated confidence coefficient must be defined. The probability of motor case rupture for this document has been set at a "one-sided" confidence interval of 10^{-5} with a confidence coefficient of 90 percent (US requirement).

G.3. TOLERANCE LIMIT PROCEDURE.

The Tolerance Limit Procedure discussed in Appendix I, Reference 31 (US) is used to determine that at a 90 percent level of confidence, the probability of motor case rupture is better than one in 100,000 (the "one-sided" confidence interval of 10^{-5}). This means that the motor case rupture pressure must be much better than the motor operating pressure. The following procedure is based upon the assumptions of independence and normality of the data. The normality of the rupture and operating pressure data can be checked by calculating the skewness and kurtosis values.

G.4. DEFINITIONS.

X - burst pressure
Y - maximum operating pressure
μ_x - mean of the population for X
μ_y - mean of the population for Y
σ_x - standard deviation of the population for X
σ_y - standard deviation of the population for Y

$\bar{X}$ - average dynamic burst pressure (estimate of μ_x)
S_x - standard deviation of burst pressure (estimate of σ_x)
n_x - burst pressure sample size
f_x - degrees of freedom of estimate S_x

$\bar{Y}$ - average static fire maximum operating pressure (estimate of μ_y)
S_y - standard deviation of the maximum operating pressure (estimate of σ_y)
n_y - maximum operating pressure sample size
f_y - degrees of freedom of estimate S_y

APPENDIX G. MARGIN OF SAFETY CALCULATIONS FOR PRESSURE VESSELS.

$f_{x\text{-}y}$ - degrees of freedom for X and Y
$S_{x\text{-}y}$ - standard deviation of the difference X - Y

and

$$\overline{X-Y} = \overline{X} - \overline{Y} \qquad \text{(G1)}$$

$$S_{x-y}^2 = S_x^2 + S_y^2 \qquad \text{(G2)}$$

When applying tolerance limits to determine the probability that X-Y>0, it is necessary to determine a sample size, $n_{x\text{-}y}$, to be used in the computation. If $n_x = n_y$, then set $n_{x\text{-}y} = n_x = n_y$. If n_x does not equal n_y, then the following shall be used to determine $n_{x\text{-}y}$.

$$n_{x-y} = \frac{s_x^2 + s_y^2}{\frac{S_x^2}{n_x} + \frac{S_y^2}{n_y}} \qquad \text{(G3)}$$

The procedure used to determine equation G3 is as follows:

a. The t-test for the equality of two means with unequal variances is:

$$t = \frac{(\bar{x} - \bar{y}) - (\mu_x - \mu_y)}{\left[\frac{S_x^2}{n_x} + \frac{S_y^2}{n_y}\right]^{1/2}} \qquad \text{(G3a)}$$

b. If $n_x = n_y = n$, the formula becomes:

$$t = \frac{(\bar{x} - \bar{y}) - (\mu_x - \mu_y)}{\left[\frac{S_x^2 + S_y^2}{n}\right]^{1/2}} \qquad \text{(G3b)}$$

APPENDIX G. MARGIN OF SAFETY CALCULATIONS FOR PRESSURE VESSELS.

c. Equating the two formulas G3a and G3b and solving for n results in equation G3.

d. The above procedure cannot be considered more than a plausible reason for equation G3; however, equation G3 does have the following desirable attributes:

(1) If $n_x = n_y$, then $n_{x-y} = n_x = n_y$.

(2) If $S_x = S_y$, then n_{x-y} is the harmonic mean of n_x and n_y.

(3) n_{x-y} is bound by n_x and n_y.

(4) If $S_x > S_y$, then n_{x-y} will be closer to n_x, and this is desirable since the larger S has the greater influence on S_{x-y} in equation G2. The degrees of freedom for X and Y are:

$$f_{x-y} = \frac{(s_x^2 + s_y^2)^2}{\frac{S_x^4}{f_x+2} + \frac{S_y^4}{f_y+2}} - 2 \qquad \text{(G4)}$$

The differences in pressure in multiples of standard deviations are:

$$K = \frac{(\bar{x} - \bar{y})}{[s_x^2 + s_y^2]^{1/2}} \qquad \text{(G5)}$$

From the computed values of equations G3, G4, and G5 and by using the One-Sided Tolerance Limit tables of values of k for various values of n, the probability of (X-Y)>0 can be determined.

G.5. OPERATING CHARACTERISTICS CURVES.

The operating characteristics curves in Figure G-1 show how the power of the test using the Tolerance Limit Procedure varies with sample size. The numbers associated with each curve denote the sample sizes to be used to measure case burst pressure and maximum generated operating pressure. The abscissa of the figure is the ratio:

$$K = \frac{(\bar{x} - \bar{y})}{[s_x^2 + s_y^2]^{1/2}}$$

APPENDIX G. MARGIN OF SAFETY CALCULATIONS FOR PRESSURE VESSELS.

This ratio has been used because, for a given sample size, the probability of passing the test depends on the ratio rather than on the absolute difference between the mean pressures. The vertical line in the figure is drawn at the criterion level of 4.26489, where the true probability of case rupture is 1/100,000 with a 90 percent level of confidence.

The test depicted in Figure G1 is designed with a consumer or Type I risk of 35 percent and criterion level of 4.26489. As one can see from the figure, the motor must be better than the criterion to have much chance of passing the test. Also, the criterion shows how the power of the test to discriminate between good and bad units increases as the sample size is increased. The curves in Figure G1 may also be used to estimate the level of extra safety that will have to be built into the units to ensure a high probability of passing the test. For example, if 10 units are to be used for testing (5 for burst pressure, 5 for maximum pressure) then to ensure an 80 percent chance of passing the test, it would be necessary to build units with a pressure difference of approximately 6.75 times as large as the standard deviation of the estimate of the difference. On the other hand, the pressure difference would only have to be approximately 5.50 times as large if 20 units were to be used for testing.

APPENDIX G. MARGIN OF SAFETY CALCULATIONS FOR PRESSURE VESSELS.

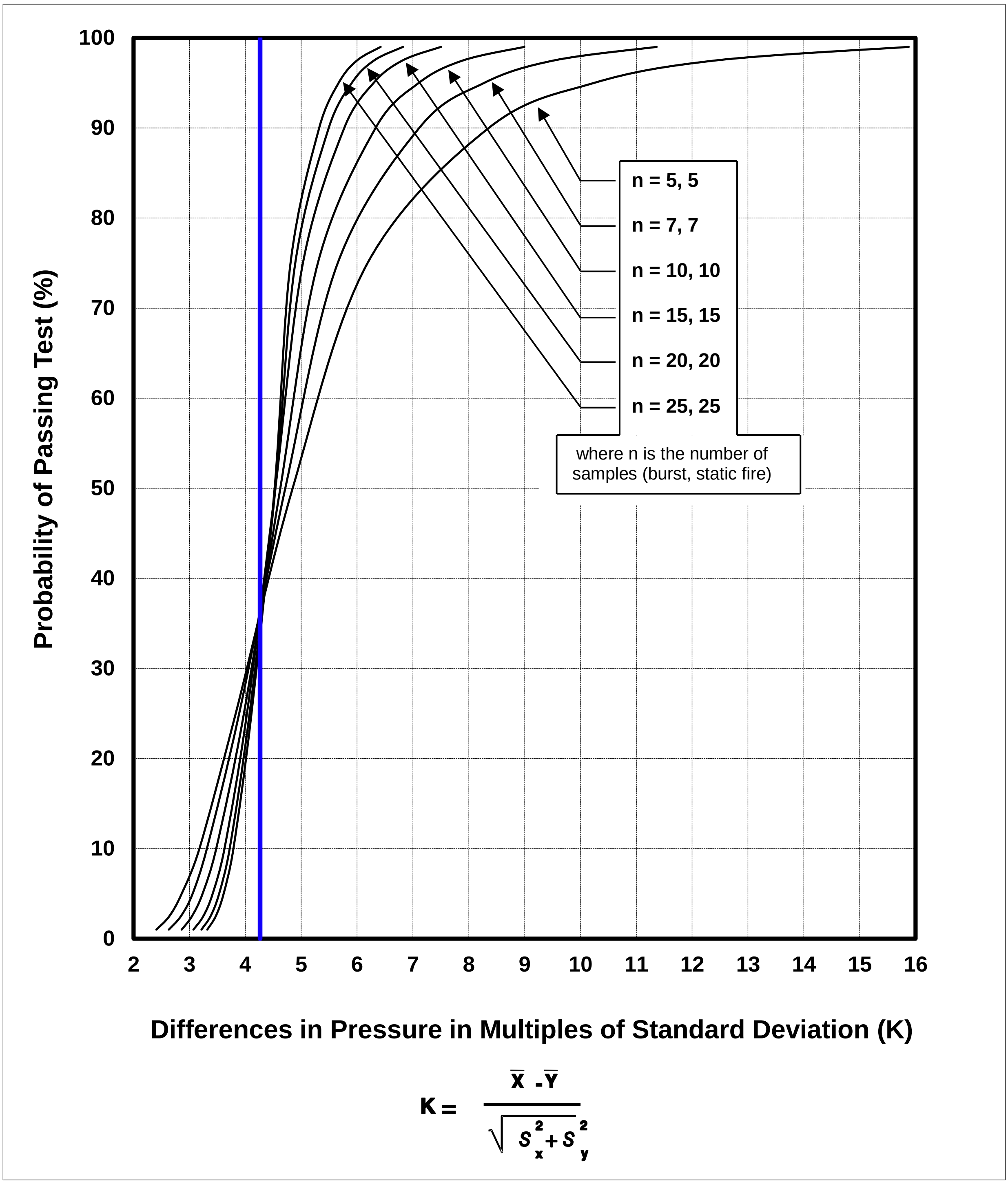

Figure G1. Operating Characteristic Curves (One-Sided Tolerance Limits).

APPENDIX G. MARGIN OF SAFETY CALCULATIONS FOR PRESSURE VESSELS.

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APPENDIX H. NON-SEQUENTIAL TESTS/ASSESSMENTS.

This document was developed within the international community and is written with references to both US and NATO test procedures to provide a framework for international procurement and test programs. Table I2-1 (Appendix I, Annex 2) provides cross reference of similar national and international test standards.

This annex provides descriptions of all of the non-sequential tests required in the S3 Test Programs included in Appendix B. Rationales for these tests are provided in Appendix A.

APPENDIX H. NON-SEQUENTIAL TESTS/ASSESSMENTS.

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APPENDIX H. NON-SEQUENTIAL TESTS/ASSESSMENTS.
ANNEX 1. ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E3).

H.1-1. HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE (HERO).

Conduct the HERO test using guidance and parameters found in MIL-STD-464 for all LCEP configurations. HERO tests are performed using one complete inert munition with instrumented inert or live Electrically Initiated Devices (EIDs) and/or ESADs. The HERO tests generally use an electric measuring chain (instrumented EIDs) that will collect measured induced current data. The explosively loaded EIDs are replaced with fiber optic instrumented versions of the inert EID. In cases where instrumentation of the device is not feasible, reasonable results can be obtained with a go/no-go technique but a considerably higher number of units and a theoretical analysis will be required.

H.1-2. ELECTROSTATIC DISCHARGE (ESD) TESTS.

H.1-2.1 Personnel Handling.

a. Personnel handling ESD tests are performed using an inert munition which contains inert or live EID's/ESAD's. A minimum of 22 complete sets of EID's/ESAD's are required (see Appendix B).

b. Conduct personnel handling ESD tests using guidance in MIL-STD-464. The discharge is applied to all connectors (protective covers removed) and electronics accessible during system checks and/or field assembly. ESAD's shall be tested while in the functional mode.

c. Inspect and test all EID’s/ESAD's for activation.

H.1-2.2 Helicopter-Borne Transportation.

a. Helicopter-borne transportation ESD tests are performed using an inert munition, which contains inert or live EID's/ESAD's. A minimum of 10 complete sets of EID's/ESAD's are required (see Appendix B).

b. Conduct helicopter-borne transportation ESD tests using MIL-STD-464.

c. Inspect and test all EID’s/ESAD's for activation.

H.1-3. LIGHTNING HAZARD.

a. The tests are performed with the weapon in the worst case configuration based on analysis of the LCEP scenario.

b. Direct or indirect (or both where appropriate) lightning tests shall be performed using inert weapons with instrumented inert or live EIDs/ESADs. A minimum of 20 complete sets of EIDs/ESADs (10 for indirect lightning strike and 10 for

direct lightning strike) are required to provide adequate data when instrumented components are not available (see Appendix B). In addition, Nation specific requirements may necessitate direct and/or indirect lightning tests on one complete live munition.

c. Perform the lightning strike tests using the parameters found in MIL-STD-464.

H.1-4. <u>ELECTROMAGNETIC COMPATIBILITY (EMC)</u>.

Where appropriate EMC susceptibility tests are carried out on one complete inert weapon and shall be completed in accordance with the MIL-STD-461 and MIL-STD-464 series of tests. EMC Source-Victim tests are carried out with an inert weapon with instrumented EIDs/ESADs. In some cases, National Standards and Regulations may also apply.

APPENDIX H. NON-SEQUENTIAL TESTS/ASSESSMENTS.
ANNEX 2. HEALTH HAZARDS.

Health hazard data is to be collected during the firing safety tests (see Appendix D, Annex 1). The hazards to be assessed for shoulder launched munitions are described below.

H.2-1. ACOUSTIC ENERGY (IMPULSE NOISE AND BLAST OVERPRESSURE).

During firing safety tests, measure blast overpressure and acoustic noise to determine if the shock wave damages structures and/or injures personnel (especially hearing). Mount the shoulder launched weapon in a test firing fixture with the weapon at the normal firing elevation. The firing position shall be free of any extraneous structures. Position blast overpressure and microphone sensors at the operator's head and at locations around the weapon. Fire the munition. Record and analyse impulse noise measurement data. Auditory hazard measurement is addressed by ISO 10843, MIL-STD-1474, and TOP 04-2-831. In addition, TR-HFM-090-ANN-H contains a compilation of different blast overpressure methodologies and analysis. In particular, the Stuhmiller and the Blast Overpressure - Health Hazards Assessment (BOP-HHA) V2 models are currently used by many organizations for occupational exposure limits. Collection of time-pressure data from weapon system testing at each operator or crew positions can be fed into a biomechanical model to compute the probability and severity of lung contusion resulting from single blast exposure within a 24 hour period.

H.2-2. TOXIC CHEMICAL SUBSTANCES (ROCKET EXHAUST GASES AND PARTICULATES).

Collect and analyze toxic chemical data during firing tests. Pretest analysis is recommended to determine most likely combustion products (gaseous and particulate) and their concentrations. The test design should encompass configurations most likely to produce the greatest toxic fume hazards. It is recommended that a minimum of three firings be conducted in the same configuration in order for statistical conclusions to be drawn from the toxic gas/fume data. Concentrations of the toxic substances, including CO, CO2, SO2, NO, NO2, HCl, HCN, and Pb, shall be measured at the operator's face and at other strategic locations. Data collection should be IAW ITOP 05-2-502 and TOP 02-2-614. The resulting values should be presented in the form of concentration versus time curves and integrated over time to produce the equivalent exposure. The toxic substances under review must be examined by toxicologists, human factors engineers, physicians, industrial hygienists and/or ecologists for potential human (exposure time and dose) health hazards. These hazards shall be evaluated with respect to the envisaged operational environment and on the basis of pertinent national laws and regulations.

H.2-3. OPTICAL RADIATING ENERGY.

During firing safety tests, ensure a complete optical radiation hazard evaluation of the munitions exhaust plume is conducted to protect system operator's and observer's eyes and skin from potential overexposure to high intensity optical radiation to include ultraviolet, visible, and infrared nonionizing radiation. This may be accomplished by installing radiometric sensors in the operator's eye positions (including one at the operator's eyepiece and any observer location) and aiming them along the flight path of the munition. For observers, install radiometric sensors perpendicular and directed toward the exhaust plume. Deploy photometrically calibrated detectors for several firings as above. Radiometric data that contains visible spectrum levels

may be reduced to provide photometric data instead. Obtain measurements of radiation capable of causing a thermal injury at the operator's face position.

H.2-4. LAUNCH SHOCK (RECOIL).

Mount accelerometer and displacement sensors on the munition and the firing fixture to determine shock levels due to weapon firing and recoil. The amount of excessive energy may be used to calculate the allowable number of rounds per 24 hour period. Testing should be conducted IAW TOP 03-2-504A.

H.2-5. LAUNCH DEBRIS.

Determine launch debris patterns, velocities, sizes, and masses using soft media fragment collection packs and high speed cameras during the dynamic firings. Collect these data outside of the operator’s position to define the launch space that is unsafe for occupancy during firings.

APPENDIX H. NON-SEQUENTIAL TESTS/ASSESSMENTS.
ANNEX 3. OPERATIONAL AND MAINTENANCE (O&M).

Operational tests assess the safety of operational and maintenance procedures and equipment during field handling exercises. Human factors engineers (HFE's) shall be involved in the planning, conduct, and evaluation of the following tests.

H.3-1. OPERATIONAL AND MAINTENANCE SIMULATION.

Soldiers using inert munitions and non-maintenance support items perform tactical transportation, system handling, and firing operations tests under simulated battlefield conditions. Human factors engineering tests during simulated firing missions include setup, built-in test equipment (BITE) checks, munition loading, and simulated firings. The operators perform target acquisition and tracking tests to determine any operational limits. Training exercises are performed with the complete training package. The operator manuals are reviewed and followed during the above. Operators wear temperate weather and arctic clothing and nuclear, biological, chemical (NBC) masks and clothing. The tester will consider performing a low-temperature (cold room) operational test to assess the soldier's ability to operate the weapon with protective gear. Live munitions may be used once enough testing has been completed to satisfy the safety authorities that the system is safe for use. Review and exercise the system support package (SSP). Assess the safety of preventive and corrective maintenance operations up to depot level. Simulated system faults may be used to exercise test sets and other test, measurement, and diagnostic equipment. Use maintenance manuals for these exercises and evaluate them in terms of safety.

H.3-1.1 Musculoskeletal Trauma.

Shoulder launched munitions are required to be lifted, carried, and operated in positions that may induce musculoskeletal trauma because of their weight and asymmetrical shape. In their packaged configurations, larger munitions may require multiple lifters to safely lift and carry the rounds. The potential musculoskeletal health hazard associated with some of these munitions is trauma from forceful exertions and non-neutral postures encountered while lifting, lowering, and carrying various munitions. These forceful exertions and non-neutral postures can lead to a variety of musculoskeletal injuries resulting in a range of outcomes from performance decrement to permanent disability.

H.3-2. HUMAN ERROR CHECKLIST.

Develop a checklist of "Common Sources of Human Error" to categorize human errors that occur during operational tests and to suggest potentially hazardous human errors that apply to the system. Develop additional safety checklists to address electrical, mechanical, and miscellaneous safety items. Information for developing this checklist is specified in MIL-STD-1472.

H.3-3. OPERATIONAL AND MAINTENANCE REPORT.

Record, describe, and score actual and potential unsafe operations and maintenance practices by using observations, video records, checklists, measurements, and operator and maintainer debriefings. Note, the experience and impressions gained by the test persons during handling

of the equipment should be recorded during and/or immediately after the tests. This could be done best in the form of standardized interviews made by persons who are experienced in social sciences (e.g., HFE's) using a catalog of previously determined questions. The interview results shall be evaluated based on social science criteria (statistical evaluation, etc.).

H.3-4. EMITTED RADIATION.

H.3-4.1 Control Methods.

Review existing data on system high-power emitters, including radio or radar band transmitters, non-coherent or coherent (laser) infrared, visible, and ultraviolet band transmitters, etc., and include radioactive sources such as optical lenses, indicators, references, etc., against appropriate safety standards. Review the methods used to control these emitters, including safety devices and operational and maintenance safety procedures.

H.3-4.2 Radiation Protection Procedures.

Non-ionizing radiation measurements are performed to provide a health hazard assessment. Special precautions may be required for items that produce ionizing radiation. For example, it may be necessary to control the exposure of personnel to the radiation. Consult with the installation Radiation Protection Officer during the test planning phase to develop radiation protection procedures for these emitters. Verify the emission characteristics of these devices, to include mapping of levels at operator or maintainer positions, if applicable.

H.3-4.3 Inadvertent Activation.

Test and analyze operations which inadvertently trigger the emitter or change its output characteristics such as operator error, EMR, climatic and dynamic environments, improper installation, interlock bypass, etc. Test and assess shields as necessary.

APPENDIX H. NON-SEQUENTIAL TESTS/ASSESSMENTS.
ANNEX 4. OTHER SAFETY TESTS/ASSESSMENTS TO BE CONSIDERED.

Additional safety tests shall be performed if data from analysis or previous testing indicate that further investigation is required. Selection is based on analysis and previous test results, including evidence of incipient failure modes. Hardware sample sizes depend on the nature of the tests.

H.4-1. INDUCED FAILURE FIRING TESTS.

When required, additional confidence in the safety of the munition may be obtained by conducting tests, wherein failures are induced in munitions, sections of munitions, munition components, and launch stations before or during firings to investigate personnel hazards and hazard area boundaries. The induced failure conditions listed below investigate the hazards created by possible design weaknesses and evaluate potential hazards identified during previous tests. Hazards caused by operator error may be used to select the types of induced failures based on the operational and maintenance tests of Appendix H, Annex 3. Evaluate all possible conditions that may cause premature launch, misfire, hang-fire, and catastrophic failure of propellant devices and warhead. Examples of induced failures to consider are:

a. Cracked or unbonded propellant grains.

b. Plugged propellant device nozzles.

c. Damaged or incorrectly installed propellant grain supports or insulation.

d. Loose propellant case components.

e. Damaged igniter.

f. Misaligned components.

g. Damaged umbilical.

h. Damaged munition restraint devices.

i. Short or open in fire control circuit.

j. Damaged or incorrectly installed fuze or S&A device.

k. Damaged or incorrectly installed safety shields or launch tubes.

l. Corrosion in critical electrical connections or interfaces.

m. Incompatibility of missile components to chemicals.

n. Defective electrical grounding systems.

APPENDIX H. NON-SEQUENTIAL TESTS/ASSESSMENTS.
ANNEX 4. OTHER SAFETY TESTS/ASSESSMENTS TO BE CONSIDERED.

H.4-2. EXTENDED TEMPERATURE CYCLE.

Some energetic materials may crack during low-temperature cycling causing potentially unsafe conditions (e.g., dangerous internal operating pressures in rocket motors). Further rationale is given in Appendix A.

a. When required, perform the extended temperature cycling test on two separate units (either component or an assembled munition). Seal these units against moisture if they or the munition are sealed in the shipping, storage, or tactical configuration.

b. Subject the units to 20 diurnal cycles between 10 °C and -51 °C. Dwell at high and low temperatures for 4 hours, with 8-hour ramps between temperature extremes.

c. The two units are radiographed to determine if cracking or separation has occurred. Static fire the units at the operational low temperature extreme to assess potential safety hazards.

H.4-3. LONG-TERM STORAGE.

At a minimum, all explosive materials in a munition shall undergo appropriate testing and assessment per STANAG 4170 and AOP-7 to determine whether each possesses properties which make it safe for consideration for use in its intended role. In addition, energetic components may be subjected to extended diurnal cycling storage tests using guidance in MIL-STD-810 Method 501. This test will thermo-mechanically stress the item yielding information that might identify potential failure modes and future safety problems. A full BTCA inspection in accordance with Appendix E should be conducted following the long-term storage test.

H.4-4. OPERATOR SAFETY.

This test assesses the rearward effects on the operator in the event a missile is mistakenly fired into a barrier before the warhead has armed. One item shall be tested at ambient temperature. The item shall be launched into a concrete barrier, which is positioned before the minimum arming distance. The change in kinetic energy shall not cause the warhead to function or any other explosive event to occur that would endanger the operator. The item may be assembled from leftover safety assessment test components or if necessary, one of the fuze arming test assets (Appendix D, Annex 1, Paragraph D.1-2) may be utilized for this test.

H.4-5. BALLISTIC SHOCK.

The test simulates a high-level transient shock that generally results from the impact of projectiles or ordnance on armoured combat vehicles, hardened targets, or other structures. Testing may be required if identified by the munition specific LCEP.

a. Munition Configuration: This test should be conducted with the munitions in

the combat transport and tie-down configuration.

b. Test Level: Test items in accordance with MIL-STD-810 Method 522.

c. Test Temperature: Stabilize all cold munitions to -46 °C and all hot munitions to the unpackaged SRE temperature prior to vibration testing. Test temperature is to be maintained throughout testing.

H.4-6. PARACHUTE DROP SHOCK – LOW VELOCITY.

Munitions may be re-supplied by low-velocity parachute delivery and are expected to remain S3 following such an event. If parachute is an expected mode of deployment, this test should be conducted as a non-sequential test on a minimum of three munitions. This test is normally required for airdrop certification and specific test requirements are subject to approval by the airdrop certifying agency.

a. Munition Configuration: Conduct this test on individual packaged or palletized munitions with appropriate parachute drop specific padding/crushable material.

b. Test Procedure: This environment may be replicated by either an aircraft drop per ITOP 07-2-509 or may be simulated with a freefall drop. For the simulated drop, conduct one drop in accordance with MIL-STD-810, Method 516, from a height of 4.3 m onto a hard surface, such as steel or concrete, to simulate a Low Velocity Air Drop. The test item is to be released such that it will impact in a base down orientation. A laboratory shock test may also be applied if it can be demonstrated to produce an equivalent velocity and loading on the munition.

c. Test Temperature: Ambient.

H.4-7. HIGH VELOCITY PARACHUTE DROP.

Munitions may be re-supplied by high-velocity parachute delivery and are expected to remain S3 following such an event. High velocity parachute systems may result in impact velocities of 27.3 m/s (90 ft/sec). If high velocity parachute is an expected mode of deployment, this test should be conducted as a non-sequential test.

a. Test Configuration. High velocity parachute drops occur in bulk munition (palletized) configuration with appropriate supplemental shock isolation commonly used for parachute drop operations.

b. Drop Height. This environment may be replicated by either an aircraft drop per ITOP 07-2-509 or may be simulated with a freefall drop. For the simulated drop, conduct one drop in accordance with MIL-STD-331, Test E5, from a height of 38 m onto a hard surface, such as steel or concrete, to simulate a High Velocity Air Drop. The test item is to be released such that it will impact in a base down

orientation.

c. Test Temperature. Ambient.

H.4-8. MALFUNCTIONING PARACHUTE DROP.

Munitions that may be re-supplied by parachute delivery are at risk of a malfunctioning parachute drop scenario and are expected to remain safe for disposal. Per MIL-STD-331, Test E5, malfunctioning parachute systems may result in impact velocities of 45.7 m/s (150 ft/sec). This test should be conducted as a non-sequential test.

a. Test Configuration. Malfunctioning parachute drops occur in bulk munition (palletized) configuration with appropriate supplemental shock isolation commonly used for parachute drop operations.

b. Drop Height. This environment may be replicated by either an aircraft drop per ITOP 07-2-509 or may be simulated with a freefall drop per with MIL-STD-331, Test E5. In order to achieve the impact velocity of 45.7 m/s (150 ft/sec), this environment is commonly replicated by a 116 m (380 ft) freefall drop unless specific and validated evidence is presented to the contrary.

c. Number of Drops. It is not expected that a munition would be dropped more than once from this extreme height during its service life; thus, only one drop is required.

d. Test Temperature. Ambient.

H.4-9. CARGO AIRCRAFT DECOMPRESSION.

Perform Rapid Decompression testing in accordance with MIL-STD-810, Method 500, Procedure III using the following test parameters:

a. Munition Configuration: Packaged munitions.

b. Conditioning Temperature: Munitions are to be preconditioned to laboratory ambient temperature.

c. Pressures: Initial pressure = 60 kPa. Final pressure = 18.8 kPa.

H.4-10. ROLL OVER.

The rollover test will simulate the accidental toppling of the loaded launcher positioned on a concrete surface. Each launcher will initially be positioned standing on the venturi and muzzle vertical orientation conditioned at upper and lower temperatures. The item under test is pushed in each four directions to ensure all sides receive an impact shock. This test may be conducted with one or more munitions to address all orientations of interest. As a

result of this test, no internal safeties should be disabled or significantly damaged creating a hazardous condition (i.e., safe for use).

APPENDIX H. NON-SEQUENTIAL TESTS/ASSESSMENTS.
ANNEX 4. OTHER SAFETY TESTS/ASSESSMENTS TO BE CONSIDERED.

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APPENDIX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS.

This appendix provides a list of abbreviations in Annex 1, and cross-reference between similar national and international test standards in Annex 2.

APPENDIX H. NON-SEQUENTIAL TESTS/ASSESSMENTS.
ANNEX 4. OTHER SAFETY TESTS/ASSESSMENTS TO BE CONSIDERED.

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APPENDIX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS.
ANNEX 1. ABBREVIATIONS.

AAS3P	Allied Ammunition Safety and Suitability for Service Assessment Testing Publication
AASTP	Allied Ammunition Storage and Transport Publication
AECTP	Allied Environmental Conditions Test Publication
ANEP	Allied Navy Engineering Publication
ANSI	American National Standards Institute
AOP	Allied Ordnance Publication
AP	Allied Publication
ARSP	Allied Range Safety Publication
BIT	built-in test
BITE	built-in test equipment
BOP-HHA	Blast overpressure – Health Hazards Assessment
BTCA	Breakdown Test and Critical Analysis
C	Celsius
cm	centimetre
CT	computed tomography
DEF STAN	Defence Standard
DMTA	dynamic mechanical thermal analysis
DSC	differential scanning calorimetry
E3	electromagnetic environmental effects
ea	each
EED	electro-explosive device
EFI	exploding foil initiator
EID	electrically initiated device
EMC	electromagnetic compatibility
EMR	electromagnetic radiation
EMRH	electromagnetic radiation hazards
EMROH	electromagnetic radiation operation hazards
EOD	explosive ordnance disposal
ESAD	electronic safe and arming device
ESD	electrostatic discharge
FM	Field Manual
FMECA	Failure Modes and Criticality Effects Analysis
FR	France
ft	feet
FTA	Fault Tree Analysis
GE	Germany
GHz	gigahertz
HERO	Hazards to Electromagnetic Radiation to Ordnance
HFE	Human Factors Engineer
Hz	Hertz
IEC	International Electrotechnical Committee
IEEE	Institute of Electrical and Electronics Engineers

APPENDIX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS.
ANNEX 1. ABBREVIATIONS.

IM	insensitive muntions
IR	infrared
ISO	International Standards Organization
ISS	In-Service Surveillance
ITOP	International Test Operations Procedure
JOTP	Joint Ordnance Test Procedure
kg	kilogram
kHz	kilohertz
km	kilometre
kPa	kilopascal
lb	pound
LCEP	Life Cycle Environmental Profile
m	metre
MIL-HDBK	Military Handbook
MIL-STD	Military Standard
min	minutes
mm	millimetre
NATO	North Atlantic Treaty Organization
NBC	nuclear, biological, chemical
NDT	non-destructive test
O&M	operational and maintenance
s	second
S3	Safe and Suitable for Service
S&A	safe and arming (device)
SAR	safety assessment report
sec	second
SRE	solar radiation equivalent
SRS	shock response spectra
SSP	system support package
STANAG	Standardization Agreement
TOP	Test Operations Procedure
UK	United Kingdom
UN	United Nations
UNDEX	underwater explosion
US	United States
UV	ultraviolet
vert	vertical
WLA	Whole Life Assessment

APPENDIX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS.
ANNEX 1. ABBREVIATIONS.

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APPENDIX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS.
ANNEX 2. REFERENCES AND RELATED DOCUMENTS.

Note: Table I2-1 cross-references similar international and national international test standards. It should not be assumed that the various methods listed in Table I2-1 are technically equivalent, or that methods other than those specified in this document will be deemed acceptable by the relevant National Authority. In addition, the various documents listed may also contain unique test severities that are only applicable to the specific nation. Alternative national or international test methods may only be used if it can be demonstrated that they are technically equivalent or superior to the referenced methods; and following the guidelines in Paragraph 1 of this document. Further advice should be sought from the relevant National Authority before alternative test methods to those specified in this document are used. Revision identifiers have been intentionally removed since the latest version of the referenced documents should be referred to.

TABLE I2-1. CROSS-REFERENCE TABLE

	SHORT TITLE	NATO	US	UK	FR	GE
1	Munitions Safety Testing	STANAG 4629	ITOP 05-2-619 MIL-STD-2105 MIL-STD-882		ITOP 05-2-619	ITOP 05-2-619
2a	System Safety	AOP-15	MIL-STD-882 MIL-HDBK-764 ITOP 05-1-060	Def Stan 00-56	AOP-15	VG 95373, DIN EN 61508 ITOP 05-1-060
2b	Definition of Pressure Terms and their Use	STANAG 4110	STANAG 4110	STANAG 4110	STANAG 4110	STANAG 4110
3	Safety Assessment	AOP-15	MIL-STD-882	AOP-15 Joint Services Publication-520		
4	Hazardous Material Classification	STANAG 4123, AASTP-3	TB 700-2 UN ST/SG/AC.10/11	Joint Services Publication 482 Chapter 4 UN ST/SG/AC.10/11	UN ST/SG/AC.10/11	STANAG 4123, AASTP-3
5	Hazardous Material Classification (Thermal Stability)	UN ST/SC/AC.10/11	TB 700-2 UN ST/SG/AC.10/11	Joint Services Publication 482 UN ST/SG/AC.10/11	UN ST/SG/AC.10/11	UN ST/SG/AC.10/11
6	Insensitive Munitions Tests	STANAG's 4240, 4241, 4382, 4396, 4496, 4526	MIL-STD-2105 STANAG's 4240, 4241, 4382, 4396, 4496, 4526	STANAG's 4240, 4241, 4382, 4396, 4496, 4526	STANAG's 4240, 4241, 4382, 4396, 4496, 4526	STANAG's 4240, 4241, 4382, 4396, 4496, 4526
7	Insensitive Munitions Assessment	AOP-39, STANAG 4439	AOP-39, STANAG 4439	AOP-39, STANAG 4439	AOP-39, STANAG 4439	AOP-39 STANAG 4439
8	Software Safety	AOP-52	ITOP 01-1-057 QAP-268 Joint Software Systems Safety Engineering Handbook	Def Stan 00-56,	AOP-52	VG 95373, DIN EN 61508 ITOP 01-1-057
9	Fuze Safety Tests	STANAG 4157, AOP-20; STANAG 4363, AOP-21;	MIL-STD-331	STANAG 4157, AOP-20; STANAG 4363, AOP-21;	Tailored Test Methods + AOP-20	STANAG 4157, AOP-20; STANAG 4363, AOP-21;

APPENDIX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS.
ANNEX 2. REFERENCES AND RELATED DOCUMENTS.

	SHORT TITLE	NATO	US	UK	FR	GE
10	Explosive Material Qualification	STANAG 4170, AOP-7	STANAG 4170, AOP-7 NAVSEAINST 8020.5C	STANAG 4170, AOP-7	STANAG 4170 AOP-7 S-CAT 17500	STANAG 4170 AOP-7
11	Human Factors	STANAG 7201	MIL-STD-1472 TOP 01-1-015 TOP 01-2-610 MIL-HDBK-46855A	Def Stan 00-25; HSE Regulations	DGA/NO/FHG/913	VG 95115 ZDv 90/20 HdE, MIL-STD-1472
12	In-Service Surveillance	STANAG 4675, AOP-62, 63, 64 AECTP-600	STANAG 4675, AOP-62, 63, 64 AECTP-600	STANAG 4675, AOP-62, 63, 64 AECTP-600	STANAG 4675, AOP-62, 63, 64 AECTP-600	STANAG 4675, AOP-62, 63, 64 AECTP-600
13	Environmental Testing	STANAG 4370, AECTPs 100, 200, 230, 240, 300, 400	MIL-STD-810	Def Stan 00-35	STANAG 4370 AECTPs 100, 200, 230, 240, 300, 400; GAM EG-13	STANAG 4370, AECTPs 100, 200, 230, 240, 300, 400; MIL-STD-810
13a	Global Climatic Data	STANAG 4370, AECTP 230 Leaflet 2311	MIL-HDBK-310 AR 70-38	Def Stan 00-35, Part 4	STANAG 4370	STANAG 4370
13b	Humid Heat	AECTP 300, Method 306	MIL-STD-810, Method 507	Def Stan 00-35, Part 3, Test CL6 Severity from Def Stan 00-35 Part 4 Ch2-01	AECTP 300, Method 306	AECTP 300, Method 306
13c	Low Temperature Storage	AECTP 300, Method 303	MIL-STD-810, Method 502	Def Stan 00-35, Part 3, Test CL5 Severity from Def Stan 00-35 Part 4 Ch2-01	AECTP 300, Method 303	AECTP 300, Method 303
13d	High Temperature Storage	AECTP 300, Method 302	MIL-STD-810, Method 501	Def Stan 00-35, Part 3, Test CL6 (for high humidity) & CL2 (for low humidity) Severity from Def Stan 00-35 Part 4 Ch2-01 if cyclic.	AECTP 300, Method 302	AECTP 300, Method 302
13e	High Temperature Cycle	AECTP 300, Method 302	MIL-STD-810, Method 501	Def Stan 00-35, Part 3, Test CL6 (for high humidity) & CL2 (for low humidity) Severity from Def Stan 00-35 Part 4 Ch2-01	AECTP 300, Method 302	AECTP 300, Method 302
13f	Solar Radiation	AECTP 300, Method 305	MIL-STD-810, Method 505	Def Stan 00-35, Part 3, Test CL3	AECTP 300, Method 305	AECTP 300, Method 305
13g	Thermal Shock	AECTP 300, Method 304	MIL-STD-810, Method 503	Def Stan 00-35, Part 3, Test CL14	AECTP 300, Method 304	AECTP 300, Method 304
13h	Temperature-Altitude-Humidity	AECTP 300, Method 317	MIL-STD-810, Method 520	Def Stan 00-35, Part 3, Test CL13	AECTP 300, Method 317	AECTP 300, Method 317
13i	Salt Fog	AECTP 300, Method 309	MIL-STD-810, Method 509	Def Stan 00-35, Part 3, Test CN2	AECTP 300, Method 309	AECTP 300, Method 309
13j	Sand and Dust	AECTP 300, Method 313	MIL-STD-810, Method 510	Def Stan 00-35, Part 3, Test CL25	AECTP 300, Method 313	AECTP 300, Method 313
13k	Immersion	AECTP 300, Method 307	MIL-STD-810, Method 512	Def Stan 00-35, Part 3,Test CL29	AECTP 300, Method 307	AECTP 300, Method 307
13l	Rain/ Watertightness	AECTP 300, Method 310	MIL-STD-810, Method 506	Def Stan 00-35, Part 3, Test CL27	AECTP 300, Method 310	AECTP 300, Method 310

APPENDIX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS.
ANNEX 2. REFERENCES AND RELATED DOCUMENTS.

	SHORT TITLE	NATO	US	UK	FR	GE
13m	Icing	AECTP 300, Method 311	MIL-STD-810, Method 521	Def Stan 00-35, Part 3, Test CL10	AECTP 300, Method 311	AECTP 300, Method 311
13n	Mold Growth	AECTP 300, Method 308	MIL-STD-810, Method 508	Def Stan 00-35, Part 3, Test CN1	AECTP 300, Method 308	AECTP 300, Method 308
13o	Contamination by Fluids	AECTP 300, Method 314	MIL-STD-810, Method 504	Def Stan 00-35, Part 3, Test CN4	AECTP 300, Method 314	AECTP 300, Method 314
13p	Aircraft Cargo Decompression	AECTP 300, Method 312	MIL-STD-810, Method 500	Def Stan 00-35, Part 3, Test CL9	AECTP 300, Method 312	AECTP 300, Method 312
13q	Vibration Test	STANAG 4370, AECTP 400	MIL-STD-810, Method 514	Def Stan 00-35, Part 3, Test M1	STANAG 4370, AECTP 400	STANAG 4370, AECTP 400
13r	Vibration Test Schedule Development	STANAG 4370, AECTP 240, Leaflet 2410	MIL-STD-810, Methods 514, 527	Def Stan 00-35, Part 5	STANAG 4370, AECTP 240, Leaflet 2410	STANAG 4370, AECTP 240; ITOP 01-01-050
13s	Commercial (Common Carrier) Transportation Vibration	AECTP 400, Methods 401, 421	MIL-STD-810, Method 514, 527	Def Stan 00-35, Part 3, Test M1, Annex A and M2	AECTP 400, Method 401	AECTP 400, Method 401
13t	Military Wheeled Vehicle Transportation Vibration	AECTP 400, Methods 401, 421	MIL-STD-810, Methods 514, 527	Def Stan 00-35, Part 3, Test M1, Annex A and M2	AECTP 400, Method 401	AECTP 400, Method 401
13u	Restrained Cargo Transport Shock	AECTP 400, Method 403	MIL-STD-810, Method 516, 527	Def Stan 00-35, Part 3, Test M3	AECTP 400, Method 417	AECTP 400, Method 417
13v	Fixed Wing Aircraft Cargo Transportation Vibration	AECTP 400, Methods 401, 421	MIL-STD-810, Methods 514, 527	Def Stan 00-35, Part 3, Test M1, Annex A and M2	AECTP 400, Method 401	AECTP 400, Method 401
13w	Helicopter Cargo Transportation Vibration	AECTP 400, Methods 401, 421	MIL-STD-810, Method 514, 527	Def Stan 00-35, Part 3, Test M1, Annex A and M2	AECTP 400, Method 401	AECTP 400, Method 401
13x	Under Water Explosion (UNDEX)	STANAG 4549 STANAG 4150 ANEP 43	MIL-S-901 ANEP 43	Def Stan 00-35, Part 3, Test M7 (or Test M3).		STANAG 4150
13y	Shipboard Vibration	AECTP 400, Methods 401, 421	MIL-STD-810, Method 528, 527; MIL-STD-167	Def Stan 00-35, Part 3, Test M1, Annex A and M2	AECTP 400, Method 401	AECTP 400, Method 401
13z	Gunfire Shock (Time Waveform Replication)	AECTP 400, Methods 405, 417, 421	MIL-STD-810, Method 519, 525, and 527	Def Stan 00-35, Part 3, Test M19 (tailored severities)	AECTP 400, Methods 405, 417, and 421	AECTP 400, Methods 405, 417, and 421
13aa	Tactical and Launch Shocks (Shock Response Spectrum)	AECTP 400, Methods 417, 421 and AECTP 240, Leaflet 249-1	MIL-STD-810, Method 516, 527	Def Stan 00-35, Part 3, Test M19 (tailored severities)	AECTP 400, Methods 417, and AECTP 240, Leaflet 249-1	AECTP 400, Methods 417, and AECTP 240, Leaflet 2491
13ab	Missile Free Flight Vibration	AECTP 400, Method 401, 421 and AECTP 240 Leaflet 2410	MIL-STD-810, Methods 514, 527	Def Stan 00-35, Part 5	AECTP 400, Method 401 and AECTP 240 Leaflet 2410	AECTP 400, Method 401 and AECTP 240 Leaflet 2410
13ac	Packaged Transit Drop	AECTP 400, Method 414	MIL-STD-810, Method 516	Def Stan 00-35, Part 3, Test M5	AECTP 400, Method 414	AECTP 400, Method 414
13ad	Acoustic Noise Testing (fatigue)	AECTP 400, Method 402	ITOP 05-2-508 MIL-STD-810 Method 515	Def Stan 00-35, Part 3, Tests M8 & M9	AECTP 400, Method 402	ITOP 05-2-508
14	Unpackaged Handling Drop	STANAG 4375	MIL-STD-810, Method 516 ITOP 04-2-602	Def Stan 00-35, Part 3, Test M5	STANAG 4375	STANAG 4375

APPENDIX I. ABBREVIATIONS / REFERENCES AND RELATED DOCUMENTS.
ANNEX 2. REFERENCES AND RELATED DOCUMENTS.

	SHORT TITLE	NATO	US	UK	FR	GE
15	Packaged and Unpackaged Safety Drops	STANAG 4375	MIL-STD-810, Method 516 ITOP 04-2-602	Def Stan 00-35, Part 3, Test M5	STANAG 4375	STANAG 4375
16	Logistic Drop Test (12 m drop)	STANAG 4375	MIL-STD-2105 ITOP 04-2-601	STANAG 4375	STANAG 4375	STANAG 4375 ITOP 04-2-601
17	Parachute Drop	AECTP 400, Method 414	MIL-STD-331 ITOP 07-2-509 TOP 04-2-509	Def Stan 00-35, Part 3, Test M5 AP101A 1102-1		AOP-20, MIL-STD-331
18	Dynamic Firing	STANAG 4157, AOP-20; STANAG 4363, AOP-21	ITOP 04-2-806	STANAG 4157, AOP-20; STANAG 4363, AOP-21	STANAG 4157, AOP-20	STANAG 4157, AOP-20; STANAG 4363, AOP-21
19	Warhead Minimum Arming Distance	STANAG 4157, AOP-20; STANAG 4363, AOP-21	ITOP 04-2-806	STANAG 4157, AOP-20; STANAG 4363, AOP-21	STANAG 4157, AOP-20	STANAG 4157, AOP-20; STANAG 4363, AOP-21
20	Warhead Arena Test		ITOP 04-2-813; MEM NA 00-130ASR-2-1 (Army FM 101-51-3-CD (EM 0260))	ITOP 04-2-813		ITOP 04-2-813; TL 1300-0011 Part 2, BWB WM VI 2 Hdb. Munitionsbewertung A 1981
21	Weapon Danger Area	STANAGs 2240, 2401, ARSP-1 Vol I and II STANAG 2470, ARSP-2, Vol. 1	ITOP 05-2-505	STANAGs 2240, 2401, ARSP-1 Vol I and II STANAG 2470, ARSP-2, Vol. 1	TTA206 STANAG 2921	STANAGs 2240, 2401, ARSP-1 Vol I and II STANAG 2470, ARSP-2, Vol. 1; ZDv 44/10, ITOP 05-2-505
22	Rocket Motor Static Firing		ITOP 05-2-500	ITOP 05-2-500		TL1376-0701, ITOP 05-2-500 AA WTD 91 07-520-004-002
23	Rocket Motor Case Burst		ITOP 05-2-621	ITOP 05-2-621		ITOP 05-2-621 VA WTD 91 07-330-16
24	Rocket Motor Case Burst Probability		ARO Report 75-2 SMC-S-001	Def Stan 07-85		
25	Health Hazards		MIL-STD-1474 TOP 06-2-507 TOP 10-2-508 OPNAVINST 5100.19E OPNAVINST 5100.23G	HSE Regulations		
26	Toxic Gas / Materials		ITOP 05-2-502 TOP 02-2-614	HSE Regulations		Erl. BMVg InSan I4-42-19-01 ITOP 05-2-502

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	SHORT TITLE	NATO	US	UK	FR	GE
27	Launch Shock/ Recoil		TOP 03-2-504A	HSE Regulations		
28	Laser Hazards	STANAG 3606, ARSP-4	TB MED 524 MIL-HDBK-828	Joint Services Publication 390. HSE Regulations. Control of Artificial Optical Radiation at Work Regulations.	STANAG 3606, ARSP-4	STANAG 3606 ARSP-4
29	Ionizing Radiation Hazards		TOP 03-2-711	HSE Regulations		
30	Electronic Equipment Hazards		MIL-HDBK-45	Def Stan 00-10 HSE Regulations		
31	Radiofrequency Health Hazards	STANAG 2345	TOP 03-2-616 OP3565 Vol. 1 DOD 6055.11	Joint Services Publication 392 Leaflet 35	ENV 501661 ENV 50061	DIN VDE-0848. T.1-4, DIN VDE-0848. T.2
32	Acoustic Noise	ISO 10843: 1997	MIL-STD-1474 ISO 10843: 1997	Def Stan 00-27 HSE Regulations ISO 10843: 1997	AT-83/27/28	ZDv 90/20 VM Blatt 1993
33	Blast Overpressure	STANAG 4569 with references. Final Report RTO-HFM-089,090,148	MIL-STD-1474 BOP-HHA V2 ISO 10843 ITOP 04-2-822 DOD 6055.9-STD	ITOP 04-2-822	Consignes et instructions relatives à l'enregistrement et à l'exploitation des bruits d'armes et des bruits de détonation	Vorschriften und Richtlinien zur Registrierung und Auswertung von Waffen und Detonationsknallen and STANAG 4569 with references. Final Report RTO-HFM-089,090,148
34	Electromagnetic Environmental Effects (tests)	STANAG 4370, AECTP 500	MIL-STD-464 TOP 01-2-511 MIL-STD-461	Def Stan 59-411	GAM DRAM 02	STANAG 4370, AECTP 500 VG 95370, VG 95373, VG 95379
35	Electromagnetic Environmental Effects (environment description)	STANAG 4370, AECTP 250, Leaflet 258	MIL-STD-464 MIL-HDBK-235	Def Stan 59-411	GAM DRAM 01	STANAG 4370, AECTP 250, Leaflet 258 VG 95370, VG 95373, VG 95379
36	Electromagnetic Environmental Effects (HERO)	STANAG 4370, AECTP 508 Leaflet 3	MIL-STD-464 MIL-HDBK-240 JOTP-61 OP3565 Vol. 2	Def Stan 59-114 Def Stan 59-411	GAM DRAM 02	STANAG 4370, AECTP 508, Leaflet 3 VG 95378, VG 95379

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	SHORT TITLE	NATO	US	UK	FR	GE
37	Electrostatic Discharge (ESD) Environmental Test	STANAG 4370, AECTP 250, Leaflet 253; AECTP 508, Leaflet 2	MIL-STD-464 JOTP-62	Def Stan 59-411	GAM DRAM 01 GAM DRAM 02	STANAG 4370, AECTP 250, Leaflet 253
38	Lightning Environmental Test	STANAG 4370, AECTP 508, Leaflet 4; AECTP 250, Leaflet 254	MIL-STD-464	Def Stan 59-411	GAM DRAM 01 GAM DRAM 02	STANAG 4370, AECTP 508, Leaflet 4; AECTP 250, Leaflet 254 VG 95379
39	Electromagnetic Interference	STANAG 4370, AECTP 501	MIL-STD-461 MIL-STD-464	Def Stan 59-411	STANAG 4370, AECTP 501	STANAG 4370, AECTP 501 VG 95370, VG 95373
40	Electromagnetic Compatibility	STANAG 4370, AECTP-250 and 500; IEC 61000 4-2	MIL-STD-461 MIL-STD-464 MIL-HDBK-237	Def Stan 59-411 IEC 61000 4-2		IEC 61000 4-2 VG 95370, VG 95373
41	Cannon Safety Test		ITOP 03-2-829			

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